Office of Technology Assessment

Congressional Board of the 98th Congress

MORRIS K. UDALL, *Arizona, Chairman*

TED STEVENS, *Alaska, Vice Chairman*

Senate

ORRIN G. HATCH
Utah

CHARLES McC. MATHIAS, JR.
Maryland

EDWARD M. KENNEDY
Massachusetts

ERNEST F. HOLLINGS
South Carolina

CLAIBORNE PELL
Rhode Island

House

GEORGE E. BROWN, JR.
California

JOHN D. DINGELL
Michigan

LARRY WINN, JR.
Kansas

CLARENCE E. MILLER
Ohio

COOPER EVANS
Iowa

JOHN H. GIBBONS
(Nonvoting)

Advisory Council

CHARLES N. KIMBALL, *Chairman*
Midwest Research Institute

EARL BEISTLINE
University of Alaska

CHARLES A. BOWSHER
General Accounting Office

CLAIRE T. DEDRICK
California Land Commission

JAMES C. FLETCHER
University of Pittsburgh

S. DAVID FREEMAN
Tennessee Valley Authority

GILBERT GUDE
Congressional Research Service

CARL N. HODGES
University of Arizona

RACHEL McCULLOCH
University of Wisconsin

WILLIAM J. PERRY
Hambrecht & Quist

DAVID S. POTTER
General Motors Corp.

LEWIS THOMAS
Memorial Sloan-Kettering Cancer Center

Director

JOHN H. GIBBONS

This is an OTA Background Paper that has neither been reviewed nor approved by the Technology Assessment Board

J952-25

BEST AVAILABLE COPY

SUSTAINING TROPICAL FOREST RESOURCES

U.S. AND INTERNATIONAL INSTITUTIONS

OTA Background Papers are documents containing information that supplements formal OTA assessments or is an outcome of internal exploratory planning and evaluation. The material is usually not of immediate policy interest such as is contained in an OTA Report or Technical Memorandum, nor does it present options for Congress to consider.

BACKGROUND PAPER #2

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D.C. 20510

Library of Congress Catalog Card Number 83-600534

For sale by the Superintendent of Documents,
U.S. Government Printing Office, Washington, D.C. 20402

Preface

This background paper explores the roles of national, regional, and international institutions and the private sector in developing and implementing technologies to sustain tropical forests. It is part of the Office of Technology Assessment's forthcoming report *Technologies To Sustain Tropical Forest Resources.* A concurrent background paper, *Reforestation of Degraded Lands,* focuses on the actual reforestation technologies available. These analyses were requested by the House Committee on Foreign Affairs and the Senate Committee on Energy and Natural Resources, and supported by the House Subcommittee on Insular Affairs of the Committee on Interior and Insular Affairs, and the Senate Subcommittee on Environmental Pollution of the Committee on Environment and Public Works.

This paper: 1) explains how U.S. and international institutions affect the development and implementation of technologies to sustain tropical forest resources; 2) reviews the capabilities of a range of selected U.S. institutions, developed and developing world institutions, funding foundations, and private sector organizations; and 3) discusses the constraints and opportunities faced by these institutions. This is not an exhaustive study; rather it reports on a broad sampling of important institutions and highlights the most troubling constraints and most promising opportunities.

Congress has both legislative and oversight responsibilities related to U.S. and international institutions, and this paper provides information designed to help Congress in those deliberations. Congress has direct responsibility for the Agency for International Development and has given the agency explicit direction to be concerned with tropical deforestation. Congress also affects the actions of the U.S. Forest Service, the U.S. Park Service, and other U.S. agencies that could play an expanded role in tropical forest efforts. Congress indirectly influences various international institutions through allotment of funds and policy direction. Thus, OTA hopes this compilation will be a useful review of many of the various institutions of concern to Congress.

This paper was prepared by OTA analyst Chris Elfring. OTA also wishes to acknowledge the tropical forest resources advisory panel and executive agency liaisons who reviewed this document and contributed helpful information to the OTA staff.

Technologies To Sustain Tropical Forest Resources Advisory Panel

Leonard Berry, *Panel Chairman*
Center for Technology, Environment, and Development
Clark University

Eddie Albert
Conservationist

Hugh Bollinger
Director
Plant Resources Institute

Robert Cassagnol
Technical Committee
CONAELE

Robert Cramer
Former President
Virgin Islands Corp.

Gary Eilerts
Appropriate Technology International

John Ewel
Department of Botany
University of Florida

Robert Hart
Winrock International

Susanna Hecht
Department of Geography
University of California

Marilyn Hoskins
Department of Sociology
Virginia Polytechnic Institute

John Hunter*
Michigan State University

Norman Johnson
Vice President, North Carolina Region
Weyerhaeuser Co.

Jan Laarman
Department of Forestry
North Carolina State University

Charles Lankester
U.N. Development Programme

Robert Owen
Chief Conservationist (retired)
Trust Territory of the Pacific Islands

Christine Padoch
Institute of Environmental Studies
University of Wisconsin

Don Plucknett
CGIAR
World Bank

Allen Putney
ECNAMP
West Indies Lab

Jeff Romm
Department of Forestry
University of California

Richard E. Schultes
Harvard Botanical Museum
Harvard University

John Terborgh
Department of Biology
Princeton University

Henry Tschinkel
Regional Office for Central American Programs
Agency for International Development
U.S. Department of State

*Resigned in July 1982.

OTA Tropical Forestry Staff

H. David Banta, *Assistant Director, OTA*
Health and Life Sciences Division

Walter E. Parham, *Program Manager*
Food and Renewable Resources Program

Chris Elfring Alison Hess
Susan Shen Bruce Ross-Sheriff

Contracted Staff

Bruce M. Rich

Administrative Staff

Phyllis Balan, *Administrative Assistant*
Nellie Hammond Carolyn Swann

OTA Publishing Staff

John C. Holmes, *Publishing Officer*
John Bergling Kathie S. Boss Debra M. Datcher Joe Henson
Doreen Foster Linda Leahy Donna Young

Contents

Chapter	*Page*
1. Introduction	3
2. Selected Institutions	7
3. Private Sector Involvement	49
4. Constraints and Opportunities	55
References	65

Chapter 1
Introduction

Tropical Forests and Woodlands, for the Purpose of the Report, Are Located at Latitudes South of 23.5° N and North of 23.5° S, and at Other Frost-Free Localities

BEST AVAILABLE COPY

Contents

	Page
Background	3
Diversity of Institutions	3
The Role of Institutions	4

Chapter 1
Introduction

BACKGROUND

Each year, some 11 million hectares of the world's remaining tropical forests are converted to other land uses or to wasteland (8). Where the cleared land is developed for sustainable agriculture, deforestation can be beneficial. But most of the forest being cleared today cannot sustain farming or grazing under current practices. Thus, potentially productive forest land is degraded into less productive grasslands and wastelands.

Deforestation can be caused by a variety of factors, depending on the site. In general, it is caused by a complex combination of demographic, cultural, political, and economic forces that are intensified by ever-growing populations in need of food, fuelwood, and employment. These increasing pressures lead to overuse and mismanagement of tropical resources (22) and perpetuate a vicious circle of resource degradation and poverty.

Where human pressure on natural resources increases rapidly, natural vegetation recedes and soil fertility drops. This triggers a chain of events: adverse changes in microclimates, reduced biologic soil activity, increased wind and water erosion, and pressures to open additional land to compensate for reduced fertility, etc., all leading to yet more pressure and more rapid deterioration of the soil and vegetative cover (26).

Deforestation has economic and environmental consequences for both the developed and the developing world. It jeopardizes U.S. imports of agricultural germ plasm, pharmaceuticals, chemical feedstocks, animals for medical research, tropical hardwoods, veneer, and wood products. Deforestation also limits the effectiveness of U.S.-funded development projects in tropical countries, reduces habitat needed by U.S. migratory wildlife species, and could upset the stability of global climates. Tropical deforestation also increases pressure on world oil supplies and plays a role in the increasing number of economic refugees seeking U.S. entry.

DIVERSITY OF INSTITUTIONS

An enormous amount of institutional activity is occurring worldwide that directly or indirectly affects tropical forest resources. The U.S. Agency for International Development, the United Nations (U.N.) agencies, the World Bank, and others have increased their attention to forestry in recent years. Nonprofit institutions and American corporations also have been involved in the search for solutions to tropical deforestation and forest management problems. And importantly, many tropical nations' governments have come to recognize that deforestation constrains their economies and their development options. Thus, many countries are making institutional changes to help slow deforestation and accelerate reforestation.

There are at least 600 forestry research institutions in the world, with at least 90 conducting significant programs related to tropical forests (27). The number of implementation-oriented institutions is similarly large. There is also a broad range of private enterprise engaged in the design, development, and implementation of technologies with potential to help sustain tropical forest resources. This paper could not identify every pertinent institution, organization, and firm. Rather, it reviews a selection of the institutions in the United

States and abroad that work to sustain tropical forest resources through basic research, technology development, technology transfer and implementation, and funding.

THE ROLE OF INSTITUTIONS

It is difficult to generalize about the roles the various institutions play in sustaining forest resources because these differ with the particular objectives of each institution. Indeed, effectively matching institution to task is itself often difficult. Some institutions are set up to support basic research, others to promote implementation. Some act locally, on small scales, while others are organized for large-scale, international, or even global efforts. Many institutions have a mandated focus, whether a particular region or a particular issue. The same individuality is true of funding foundations and the private sector. Each institution, foundation, and firm has unique goals, so each also has unique potentials.

Since the problems relating to tropical forest resources are themselves broad and variable, this institutional diversity can be an asset. With such diversity, it is possible to combat the problems on many fronts, on a variety of levels, and with a range of approaches. This diversity means that there are mechanisms to act both to plant trees needed for immediate needs and to conduct the research needed to develop sustainable forestry systems for the future. It means there are institutions to work at the village level and others to coordinate international efforts. The institutional diversity also ensures that there will be no unrealistic search for the "one answer" to deforestation problems.

This diversity of function and goals, however, can create problems and inefficiencies. Often, different institutions can work at cross purposes, with or without knowledge of the other's actions. Other times, there is unnecessary duplication of efforts. On occasion, there can be an unhealthy, and certainly counter-productive, "competition" between organizations or between assistance-giving nations. Often, there simply is a lack of communication among the various groups. Coordination and cooperation must be improved if deforestation is to be combated effectively.

Chapter 2

Selected Institutions

Contents

	Page
Introduction	7
U.S.-Based Institutions	7
National Science Foundation	7
National Academy of Sciences	7
Agency for International Development	9
Peace Corps	10
U.S. Department of Agriculture	10
Department of the Interior	12
Department of State	13
Smithsonian Institution	14
Organization for Tropical Studies, Inc., Durham, N.C.	14
Universities for International Forestry, Syracuse, N.Y.	15
South-East Consortium for International Development, Chapel Hill, N.C.	15
New York Botanical Garden, Bronx, N.Y.	16
Arnold Arboretum, Harvard University	16
Pacific Tropical Botanical Garden, Lawai, Kauai, Hawaii	16
Missouri Botanical Garden, St. Louis, Mo.	17
Volunteers in Technical Assistance, Arlington, Va.	17
World Wildlife Fund-United States, Washington, D.C.	17
National Wildlife Federation, Washington, D.C.	18
Sierra Club, International Earth Care Center, New York, N.Y.	18
CARE, New York, N.Y.	18
The Nature Conservancy, International Program, Leesburg, Va.	18
Rare Animal Relief Effort, New York, N.Y.	19
East-West Center, Honolulu, Hawaii	19
Natural Resources Defense Council, International Project, Washington, D.C.	19
Developed World Institutions	20
Canada	20

	Page
France	20
Japan	21
Sweden	21
United Kingdom	21
West Germany	23
Developing World Institutions	23
Brazil	23
Cameroon	25
Ghana	25
Indonesia	25
Ivory Coast	26
Liberia	26
Malaysia	26
Mexico	27
Nigeria	28
Papua New Guinea	28
Philippines	28
Thailand	29
Regional Institutions	30
BIOTROP, Bogor, Indonesia	30
Centro Agronomico Tropical de Investigacion y Ensenanza, Turrialba, Costa Rica	30
Eastern Caribbean Natural Areas Management Program, Christiansted, St. Croix	30
International Council for Research in Agroforestry, Nairobi, Kenya	31
International Institutions	31
World Bank, Washington, D.C., U.S.A.	31
Inter-American Development Bank, Washington, D.C., U.S.A.	32
Asian Development Bank, Manila, Philippines	32
Food and Agriculture Organization of the United Nations, Rome, Italy	33
Consultative Group on International Agricultural Research, Washington, D.C., U.S.A.	34
United Nations University, Tokyo, Japan	35
United Nations Environment Programme, Nairobi, Kenya	35
United Nations Educational, Scientific, and Cultural Organization, Paris, France	36
International Union of Forestry Research Organizations, Vienna, Austria	37
International Society of Tropical Foresters, Bethesda, Md., U.S.A.	37
World Wildlife Fund-International, Gland, Switzerland	37
International Union for the Conservation of Nature and Natural Resources, Gland, Switzerland	37
Lutheran World Service, Lutheran World Federation, Geneva, Switzerland	38
Lutheran World Relief, New York, N.Y., U.S.A.	38
Private Funding Foundations	38
Selected Foundations	39
Foundations: Constraints and Opportunities	44

List of Tables

Table No.	*Page*
1. Institutions Included	8
2. OTS Member Institutions, 1981-82	15
3. Private U.S. Foundations Funding Tropical Forestry Research and Projects	39

Chapter 2

Selected Institutions

INTRODUCTION

This section describes selected institutions in the United States and abroad that deal with technologies to sustain tropical forest resources. The activities, staff, funding, and potentials of more than 50 governmental and nongovernmental institutions are examined, with special emphasis on U.S.-based institutions and major international organizations funded by the United States. Selected regional and national institutions in 20 countries of the developed and developing world are also described (see table 1).

Although this section attempts to describe a broad selection of research and implementation institutions—their purposes, strengths, and weaknesses—it cannot cover all the institutions that exist. The activities of most of the more significant U.S. and international institutions are described, but the selection of non-U.S. institutions is necessarily limited.

U.S.-BASED INSTITUTIONS

National Science Foundation (NSF)

NSF is the principal institution through which the Federal Government funds basic scientific research by U.S. citizens. It is the main funding source for U.S. research in tropical biology and ecology. NSF funding is also the principal support for research sojourns of U.S. scientists in tropical countries, thereby promoting international cooperation and information exchange.

Most NSF funding related to tropical forests is awarded through its Environmental Biology Section, which is one of five sections in the Biological, Behavioral, and Social Sciences Division. In fiscal year 1981, the total NSF budget was $1.08 billion, of which $41.1 million were alloted to the Division of Environmental Biology, with $8.6 million going for tropical biology.

National Academy of Sciences (NAS)

Most NAS activities related to sustaining tropical forest resources are conducted through the Board on Science and Technology for International Development (BOSTID) of the Office of International Affairs of the National Research Council. BOSTID's total annual budget is about $6 million. It has a full-time staff of about 45, approximately half of whom are professionals. As a rough estimate, about 20 percent of BOSTID activities are related to sustaining tropical forest resources.

Over the past few years, BOSTID, through its Advisory Committee on the Sahel, has assisted the U.S. Agency for International Development (AID) and the governments in the Sahel in efforts to develop stable food supply systems, a goal in turn dependent on maintenance and rehabilitation of local ecosystems.

The BOSTID Advisory Committee on Technology Innovation is doing a series of studies on useful tropical forest genetic resources, including two studies on firewood crops. In addition, BOSTID recently completed a study on the diffusion of biomass-based, renewable energy technologies for the Rockefeller Foundation.

Finally, the BOSTID Committee on Research has begun a 5-year Research Grants Program which will award about 150 grants (averaging $100,000) in 14 research areas. Of the first six

Table 1.—Institutions Included

U.S.-based institutions

1. National Science Foundation
2. National Academy of Sciences
3. Agency for International Development
4. Peace Corps
5. U.S. Department of Agriculture:
   - Office of International Cooperation and Development
   - Agricultural Research Service
   - Forest Service
   - Soil Conservation Service
   - Cooperative State Research Service
6. Department of Interior
   - National Park Service, International Affairs Staff
   - Fish and Wildlife Service, International Affairs Staff
7. Department of State (including U.S. Man and the Biosphere Project)
8. Smithsonian Institution
9. Organization for Tropical Studies
10. Universities for International Forestry
11. South-East Consortium for International Development
12. The New York Botanical Garden
13. Arnold Arboretum, Harvard University
14. Pacific Tropical Botanical Garden
15. Missouri Botanical Garden
16. Volunteers in Technical Assistance
17. World Wildlife Fund—United States
18. National Wildlife Federation
19. Sierra Club
20. CARE
21. The Nature Conservancy, International Program
22. Rare Animal Relief Effort
23. East-West Center
24. Natural Resources Defense Council, International Project

Developed world institutions

1. Canada:
   - Canadian International Development Agency
   - International Development Research Center
2. France:
   - Centre Technique Forestier Tropical
3. Japan:
   - Japanese Overseas Afforestation Association
4. Sweden:
   - Swedish International Development Agency
5. United Kingdom:
   - Overseas Development Administration
   - Intermediate Technology Development Group
   - Institute for Terrestrial Ecology
   - Commonwealth Forestry Institute
6. West Germany:
   - Bundesministerium für Wirtschaftliche Zusammenarbeit
   - Duetsche Gesellschaft für Technische Zusammernarbeit

Institutions in developing countries

1. Brazil
2. Cameroon
3. Ghana
4. Indonesia
5. Ivory Coast
6. Liberia
7. Malaysia
8. Mexico
9. Nigeria
10. Papua New Guinea
11. Philippines
12. Thailand

Regional institutions

1. BIOTROP
2. Centro Agronomico Tropical de Investigacion y Ensenanza
3. Eastern Caribbean Natural Areas Management Program
4. International Council for Research in Agroforestry

International institutions

1. World Bank
2. Inter-American Development Bank
3. Asian Development Bank
4. Food and Agriculture Organization of the United Nations
5. Consultative Group on International Agricultural Research
6. United Nations University
7. United Nations Environment Programme
8. United Nations Educational, Scientific, and Cultural Organization
9. International Union of Forestry Research Organizations
10. International Society of Tropical Foresters
11. World Wildlife Fund-International
12. International Union for the Conservation of Nature and Natural Resources
13. Lutheran World Service, Lutheran World Federation
14. Lutheran World Relief

SOURCE: Office of Technology Assessment.

research areas selected, three deal with tropical forest related resources: grain amaranth, nitrogen-fixing trees, and biological nitrogen fixation.

Other tropical forest related research has been undertaken by the NAS Assembly of Life Sciences. The two most recent projects were a report on Research Priorities in Tropical Biology (1980) and a study on the Ecology of Development in the Humid Tropics (1982).

Agency for International Development (AID)

AID is the largest U.S. bilateral development agency. In fiscal year 1982, AID received total appropriations of $4.37 billion, of which approximately $139 million were used for projects or project components concerning forestry, natural resources, and environment. A part of AID's money goes to finance other institutions listed in this paper.

As of January 1982, AID had 96 ongoing and planned bilateral assistance projects in 37 countries that had forestry-related components. Their total "life of project" cost was $772 million, of which $216 million were forestry related. More than three-quarters of the forestry-related funds were earmarked for activities other than actual tree planting. Most AID-funded tree planting occurs under Public Law 480 "Food for Peace" programs, which receive over $1.6 billion a year and are administered by AID. (Public Law 480 programs will be discussed in more detail after examining other components of AID's tropical forest resource related activities.)

AID recently received a number of specific congressional mandates to devote more resources to forests and forest-related problems in the developing world. In 1979, section 103(b) of the Foreign Assistance Act was amended to provide explicit authorization for assistance to "maintain and increase forest resources." Section 118 of the Foreign Assistance Act authorizes AID to develop and strengthen "the capacity of less developed countries to protect and manage their environment and natural resources." In 1981, section 118 was further amended to express congressional concern "about the continuing and accelerating alteration, destruction, and loss of tropical forests in developing countries." A new subsection (d) of section 118 instructs the President to consider the recommendations of the U.S. Interagency Task Force on Tropical Forests in formulating and carrying out development assistance programs. It also calls on the President to instruct U.S. representatives to international organizations to place higher priority on the tropical deforestation problem and to improve cooperation among these organizations in regard to tropical forests.

Recently, AID increased efforts to collaborate with other bilateral development agencies, especially in Africa, and with other international and regional organizations such as the Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE), the International Council for Research in Agroforestry (ICRAF), and the Food and Agriculture Organization (FAO). As an example, the United States, United Kingdom, Belgium, Canada, France, and West Germany have formed a Cooperation for Development in Africa (CDA) group. CDA will coordinate the efforts of the development assistance agencies to aid African countries in reforestation and fuelwood programs. AID also has increased its collaboration with the Peace Corps as a result of a 1980 cooperative agreement under which the Peace Corps will train and place forestry and conservation volunteers for joint AID/Peace Corps projects. AID and the Peace Corps also have sponsored a number of regional forestry workshops in Latin America and Asia.

AID has increased its forestry staff by three times in the last 3 years. It also received support from a Resource Support Services Agreement with the U.S. Forest Service (FS). The resulting Forestry Support Program provides natural resource specialists to help AID projects around the world. In addition, the Forestry Support Program acts as a clearinghouse to put AID in touch with forestry and natural resource consultants and institutions as they may be needed.

Public Law 480, title II assistance, plays an important role in AID's forest resource assistance, but exact figures are not available. Title II authorizes food donations for emergency or disaster relief, and for assistance programs such as Food for Work and the FAO World Food Program. Both these programs have the goal of alleviating the need of poor people in the developing world for food assistance. The requested appropriation for all title II programs in fiscal year 1983 is $650 million.

Some tree planting occurs under title II Emergency Food Aid programs, but more is undertaken through Food for Work programs. It is estimated that 1982 U.S. support of World Food Program forestry projects is between $10 million and $12 million a year. Altogether, title II Food for Work and FAO World Food Program contributions are responsible for funding the planting of at least twice as many trees worldwide as AID bilateral assistance projects, although there are still problems with maintaining the trees planted.

Peace Corps

In 1982, the Peace Corps had over 400 volunteers working on projects concerned with conservation and natural resources. Approximately half are involved with forestry related activities. Peace Corps forestry projects focus on reforestation, village fuelwood lots, agroforestry, and promotion of wood-conserving technologies (such as efficient stoves).

The Peace Corps Forestry Sector Staff in Washington, D.C., is minimal (four people in 1982). Because of budget cutbacks, there is no longer any staff on loan from the U.S. Forest Service.

As a consequence of a U.S. Interagency Task Force on Tropical Forests recommendation, the Peace Corps and AID signed a collaborative agreement in 1980 for fiscal year 1982-83. Under the agreement, AID provides financial support to further Peace Corps professional technical programing while the Peace Corps will train and place its volunteers in AID natural resources and forestry projects around the world.

U.S. Department of Agriculture (USDA)

USDA administers both research and implementation programs related to technologies to sustain tropical forest resources. The most important programs are administered by the Office of International Cooperation and Development, the Agricultural Research Service, the Forest Service, the Cooperative State Research Service, and the Soil Conservation Service.

Office of International Cooperation and Development (OICD)

OICD is USDA's foreign development arm. OICD's funding comes principally from AID and international agencies such as FAO and the Organization of American States (OAS). In a typical year, OICD administers approximately 150 development assistance projects in 57 countries (principally with AID). A number of these OICD-AID projects deal directly or indirectly with tropical forest resources. In addition, OICD conducts technical assistance programs for non-AID countries on a fully reimbursable basis.

OICD also acts as the liaison between USDA and international organizations and promotes scientific exchanges and training programs. Of 47 training courses offered by OICD in 1982 in conjunction with AID and a number of U.S. universities, three or four dealt directly with tropical forest resources.

Finally, OICD administers foreign agricultural research grants that are financed with foreign currencies accruing to the credit of the United States from sales of farm products abroad under Public Law 480. Of 239 foreign agricultural research grants active as of September 1981, three could be considered to be directly related to sustaining tropical forest resources. These three grants were for sums of approximately $165,000, $53,000, and $148,000 for genetic improvement of *Eucalyptus* and other fast-growing species in Egypt, improvement of mysorgum trees in India, and evaluation of hydrologic performance and soil conservation measures on comparative watersheds in the subtropical scrub zone of Pakistan. Much

more of foreign currency is available from Public Law 480 food sales in India, Pakistan, and Egypt and could be used to finance additional forest research.

Agricultural Research Service (ARS)

ARS conducts a number of activities relevant to technologies to sustain tropical forests, most importantly its activities aimed at improving productivity on exploited tropical lands, thus reducing pressures to convert remaining tropical forests to agriculture.

ARS administers:

- the Soil and Water Conservation Research Unit at Rio Piedras, Puerto Rico,
- the Plant Research and Insect Population Control Research Unit at St. Croix in the Virgin Islands, and
- the Mayaguez Institute of Tropical Agriculture (MITA) in Mayaguez, Puerto Rico.

The Soil and Water Conservation Research Unit is particularly concerned with increasing productivity in highly acidic tropical soils with low fertility and in developing effective soil, water, fertilizer, and crop management systems on humid, hilly, tropical lands. Its budget for fiscal year 1981 was $421,000; the staff had four senior scientists. The Plant Research and Insect Population Control Research Unit had a staff in fiscal year 1981 of one entomologist and four technicians; the budget was $186,000.

MITA conducts some research programs concerning nutritional improvement of grain legumes and beans, tropical leaf proteins, rare tropical fruits, etc., which may indirectly help to sustain tropical forests by increasing the efficiency of tropical agriculture. For fiscal year 1981, MITA had a budget of just over $1 million and a staff of 6 scientists and 27 technicians and support staff.

In addition, ARS administered in fiscal year 1982 $3,715,000 of funds for tropical agricultural research under section 406 of Public Law 89-808. Most section 406 moneys are administered through U.S. land grant universities having tropical or subtropical programs, such as the University of Florida, the University of Hawaii, the University of Puerto Rico, the College of the Virgin Islands, and the University of Guam. Hawaii is the focus for research concerning the Pacific basin, and Florida and Puerto Rico are the centers for research on agricultural problems concerning Latin America, the Caribbean, and West Africa.

Forest Service (FS)

FS operates two research organizations concerned with managing and sustaining tropical forest resources—The Pacific Southwest Forest and Range Experiment Station (PSW), and its Institute of Pacific Islands Forestry (IPIF) in Hawaii, and the Institute of Tropical Forestry of the Southern Forest Experiment Station in Rio Piedras, Puerto Rico.

PSW has the largest tropical forestry research program within the U.S. Forest Service. Research has included timber and watershed management, ecosystem dynamics, threatened and endangered birds and plants, forest protection, forest soils, and biomass for energy. For fiscal year 1982, IPIF had a budget of $1.3 million and 29 scientific staff. The fiscal year 1983 budget is $855,400; the staff size has been reduced to 15.

PSW conducts research outside Hawaii in the U.S. Pacific Territories—the Trust Territory of the Pacific Islands, Commonwealth of Northern Marianas, Guam, and American Samoa. PSW is (1982) supporting forestry research by one biologist on Yap and a forester in the Marshall Islands, with backup support from the IPIF. PSW has conducted forestry research on Guam for 17 years, but recent budget cuts have reduced IPIF programs. For instance, one project managing Pacific island forest ecosystems, primarily in Hawaii, was eliminated as of May 1982. Another project on forestry resource assessment in the American Pacific islands (American Samoa, Guam, Palau, Yap, Northern Mariana Islands, etc.) underwent major cuts in October 1982.

Over the past 40 years, the Institute of Tropical Forestry at Rio Piedras, Puerto Rico, has done much research on timber management and plantation silviculture. The budget for fis-

cal year 1982 was $836,000, an increase in absolute figures over previous years, but actually a substantial decline in real resources available, with budgeted scientist-years declining from 7.5 to 4.9 in 1981. The Institute has an extensive tropical forestry library and access to both moist and dry experimental forest reserves at the Luquillo Experimental Forest (11,000 hectares (ha)) (also called the Caribbean National Forest), in Cambalace (250 ha) and in the Virgin Islands at the 50-ha Estate Thomas Experimental Forest. The Institute collaborates with the University of Puerto Rico, MITA, the Virgin Islands Government, the U.S. Fish and Wildlife Service, and several universities on the U.S. mainland.

Soil Conservation Service (SCS)

SCS had a 3-year (1979-82), $2.13 million contract with AID to provide a Soil Management Support Service (SMSS) to less developed countries (LDCs). Proper soil classification is a prerequisite for determining the possible sustainable uses of tropical forest ecosystems. Many LDCs lack the personnel and institutional capacity to develop detailed knowledge of their soils and the possible uses. Thus, the purpose of the SMSS program is to develop the institutional prerequisites for soil conservation, maintenance of soil fertility, and soil based agrotechnology use in tropical and subtropical countries.

SMSS has a staff of 5 scientists and a 12-member advisory panel. In fiscal year 1980, SMSS provided technical assistance and aided in soil science technology transfer in Sudan, Tanzania, Senegal, Ecuador, Surinam, French Guyana, Belize, Thailand, Western Samoa, Indonesia, Syria, and Jordan.

Cooperative State Research Service (CSRS)

CSRS allocates Federal funds for agricultural and forestry research to universities and research institutions in the 50 States. CSRS financed 13 research projects in 1982 that were related to sustaining tropical forest resources. Six of these were at the University of Hawaii at Honolulu, and the others were at the University of Washington at Seattle, the University of Florida at Gainesville, the University of Michigan at Ann Arbor, North Carolina State University at Raleigh, the University of Illinois at Urbana, and Purdue University.

Department of the Interior

National Park Service (NPS)

Domestically, NPS manages eight units totaling about 2 million acres which include appreciable segments of tropical forests. Some of the largest units are Hawaii Volcanoes, Haleakala, Virgin Islands, and Everglades National Park. Activities at these areas include a wide range of natural resource protection, resource management, research, and visitor service programs.

The International Park Affairs Branch of NPS undertakes park planning, management, and conservation activities, as well as training programs, in collaboration with foreign governments and international and nongovernmental institutions. These activities are carried out in response to various statutes and conventions such as the Convention Concerning the Protection of the World Cultural and Natural Heritage, the Convention on Nature Protection and Wildlife Conservation in the Western Hemisphere, Executive Order 11911, and the Endangered Species Act.

Of some 90 ongoing and proposed international projects for fiscal years 1982-83, about one-third were in some way concerned with sustaining tropical forest resources. The Branch manages an AID-financed project under which a book entitled "Ecological Aspects of Development in the Humid Tropics" was published in 1982 (in cooperation with several universities and the U.S. National Research Council), and a series of regional development case studies from Latin America and the Caribbean are being prepared (in cooperation with OAS). Other recent activities include assistance with a Ranger Skills Training Course for 15 Panamanian park rangers; technical assistance in India's Kanha National Park and Saudi Ara-

bia's Asir Kingdom Park; a Wildlife Management Training Course for Peace Corps volunteers and their counterparts from Paraguay, Guatemala, Ecuador, and Costa Rica; and annual international seminars and workshops on park-related matters.

The Branch has a professional staff of 14, 3 trained in forestry, as well as language capabilities in Spanish, Urdu, Portuguese, and Arabic. The considerable expertise of NPS could be more fully used to support tropical forest resources if given a clear mandate to do so. The Branch's budget for fiscal year 1982 was approximately $460,000. Because of the collaborative nature of most of the projects in which it participates, the scope of its ongoing activities is considerably larger than its small budget indicates.

Fish and Wildlife Service

The Fish and Wildlife Service has authority under a number of statutes and conventions to undertake cooperative activities relating to conservation of tropical forest fauna and habitats. Two of the most important are section 8 of the Endangered Species Act (which gives authority to tap various funding sources to transfer wildlife management techniques abroad) and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere.

Recent activities have included a cooperative program with the Peace Corps to conduct a biological inventory in Paraguay and create a natural history museum; training wildlife professionals, mostly in Latin America, with priority on establishing national wildlands programs; and teaching sustained-yield management of Amazonian forest wildlife resources in Ecuador and Brazil.

The Service is an underused institutional resource for implementing technologies to sustain tropical forest resources. The Fish and Wildlife Service has a long-standing legal mandate to conduct international cooperative programs to sustain wildlife resources and internationally recognized expertise. For fiscal year 1982, total resources committed to international activities in the Western Hemisphere amount to only $25,000 and 2 person-years. The rest of its fiscal year 1982 international program related to tropical countries consists of a commitment of 1 person-year for India, and $400,000 in excess Indian currency from Public Law 480 programs.

The International Staff of the Fish and Wildlife Service has formed working partnerships with the National Wildlife Federation, the World Wildlife Fund-U.S., and a number of other U.S. nongovernmental agencies (NGOs) concerned with destruction of tropical forest habitats.

Department of State (Including U.S. Man and the Biosphere Program)

The State Department Office of Food and Natural Resources has been active in promoting and coordinating a number of activities to help the United States formulate a tropical forest resource strategy. These activities include the U.S. Strategy Conference on Tropical Deforestation, held jointly with AID in 1978, the Inter-Agency Tropical Forest Task Force strategy document published in 1980, and the State Department/AID Strategy Conference on Biological Diversity, held in November 1981. Although the Inter-Agency Task Force on Tropical Forests continues to be the key U.S. governmental institution for coordinating and preparing U.S. policy positions on tropical forest resource issues, it took no new initiatives in 1982 to promote the implementation of the strategy set out in the 1980 Task Force report.

The State Department also provides personnel for the U.S. Man and the Biosphere (MAB) Secretariat and coordinates the U.S. Committee for the UNESCO MAB Program. In the past 2 years, the U.S. MAB has seen a drastic curtailment of activities. Only 4 projects could be funded in fiscal year 1982, as opposed to 9 in fiscal year 1981 and 16 in fiscal year 1980. Funding levels for fiscal year 1983 had not yet been determined as of January 1983 (20). In past years, between one-third and one-half of the MAB research has concerned tropical forest resources. Many experts believe that MAB

funding could make important inroads into tropical forest problems and decry the reductions in support that have occurred.

Smithsonian Institution

The Smithsonian Institution is one of the lead institutions in the United States doing basic research for conservation of tropical forest ecosystems. Tropical forest research is conducted primarily by the following organizations of the Smithsonian: the National Museum of Natural History, the Smithsonian Tropical Research Institute (STRI) in Panama, the Office of Biological Conservation, the National Zoological Park, and the U.S. National Herbarium.

The National Museum of Natural History is undertaking a strategic studies program on critically endangered tropical and desert habitats, with the goal of preparing predictive ecosystem models. Other research includes studies in the central highands of New Guinea and Brazil.

The Smithsonian Tropical Research Institute in Panama administers Barro Colorado Island, located in Gatun Lake in the Canal Zone. Barro Colorado is a biological reserve of significant scientific importance, and researchers from all over the world come to study its fauna and flora. Under a recently signed agreement with the Government of Panama, STRI will administer a 5,400 ha Barro Colorado Nature Monument, including not only the island of Barro Colorado but also a number of other islands and adjacent areas. STRI is conducting a number of research activities, including studies of tropical forest succession, anteater predation, the role of mycorrhizae in tropical tree growth, and the socioeconomics of alternative farming systems. In addition, STRI has created an Office of Conservation and Environmental Education with two full-time staff.

The Office of Biological Conservation has a Threatened Plants Committee which is working with IUCN on a Latin American Program to inventory endangered plant species and their habitats in Latin America.

The National Zoological Park (NZP) is conducting field research concerning tropical forest flora and fauna and their habitats in a number of countries, including Madagascar, Venezuela, Sri Lanka, Nepal, and Indonesia. Other NZP research deals with methods to sustain its captive collection of species including endangered species from tropical forest habitats and with ecological theory.

Finally, the U.S. National Herbarium of the Smithsonian is the third largest herbarium in the United States. Many of its 4.1 million specimens are from tropical areas of the Western Hemisphere. Thus, it is an important national and international resource for research concerning neotropical flora.

Organization for Tropical Studies, Inc. (OTS), Durham, N.C.

OTS is a consortium of 22 American and 3 Costa Rican universities whose purpose is to promote research in tropical biology and ecology. Member institutions as of 1981-82 are in table 2.

OTS has a 3,500-acre field station in Costa Rica, Finca La Selva. Sixty-five percent of La Selva is undisturbed lowland tropical wet forest; the rest consists of abandoned pastures or secondary forest. Since its founding in 1963, OTS has provided facilities for thousands of scientists to study tropical habitats at La Selva and also at other sites in Costa Rica. OTS also conducts graduate training programs that introduce young scientists to the complexities of field research in the tropics. Over 1,300 scientists have participated in these training programs.

OTS plans to become involved in tropical ecosystem research (there are two proposals in process for 1983). OTS headquarters are at Duke University, where there is a four-person staff; the Costa Rican staff numbers about 10. Funding comes from membership dues ($5,000 per year for each institution) and from support and maintenance grants from NSF. For the period 1982-85, the NSF maintenance grant is approximately $500,000.

Table 2.—OTS Member Institutions, 1981-82

University of California (System) Berkeley, Calif.	Duke University Durham, N.C.	University of Michigan Ann Arbor, Mich.	University of Southern California Los Angeles, Calif.
University of California Los Angeles, Calif.	University of Florida Gainesville, Fla.	University of Minnesota Minneapolis, Minn.	State University of New York Stony Brook, N.Y.
University of Chicago Chicago, Ill.	University of Georgia Athens, Ga.	Museo Nacional de Costa Rica San Jose, Costa Rica	Texas Tech University Lubbock, Tex.
University of Connecticut Storrs, Conn.	Harvard University Cambridge, Mass.	Universidad Nacional Heredia Costa Rica	University of Washington Seattle, Wash.
Cornell University Ithaca, N.Y.	University of Iowa Iowa City, Iowa	University of North Carolina Chapel Hill, N.C.	Washington University St. Louis, Mo.
Universidad de Costa Rica Ciudad Universitaria Costa Rica	University of Kansas Lawrence, Kans.	Smithsonian Institution Washington, D.C.	University of Wisconsin Madison, Wis.
	University of Miami Coral Gables, Fla.		

SOURCE: B. Rich, "Institutions That Deal With Technologies To Sustain Tropical Forest Resources," OTA commissioned paper, 1982.

Universities for International Forestry (UNIFOR), Syracuse, N.Y.

UNIFOR is a consortium of seven U.S. universities that have international programs in the management of forest and forest dependent resources. It was founded in 1978. The member universities are the State University of New York, College of Environmental Science and Forestry at Syracuse; the University of Washington College of Forest Resources at Seattle; the North Carolina State University School of Forest Resources at Raleigh; the University of Michigan School of Natural Resources at Ann Arbor; the University of Idaho College of Forestry, Wildlife, and Range Sciences at Moscow; and the University of Arizona School of Renewable Resources at Tucson.

The objective of the consortium is to provide a basis for combining the faculty, staff, and other resources of the cooperating institutions in order to conduct joint programs of education, training, research, and other professional services in the field of forestry and forestry-related problems in developing countries.

The UNIFOR universities have had substantial experience in tropical countries in disciplines such as forest and range resources management and analysis, agroforestry, environmental impact assessment, forest conservation and protection, forest soil and water relationships, forest and range wildlife management, and the sociocultural context of forest resources.

South-East Consortium for International Development (SECID), Chapel Hill, N.C.

SECID, founded in 1977, is a consortium of 32 academic and research institutions in the Southern and Eastern United States. SECID includes certain 1890 Land Grant Institutions, Tuskegee Institute, 11 of the 1862 Land Grant Universities, Duke University, the University of North Carolina at Chapel Hill, Georgia Institute of Technology, and the Research Triangle Institute. SECID coordinates the resources of member institutions to collaborate on projects that provide research, training, and extension services to developing nations and to resource-poor people in the United States. In 1980, SECID had total expenditures of $5.2 million.

SECID is divided into Offices of Training, Administration, and Institutional Development; Program Development; and Environmental Management. Only the Office of Environmental Management has been directly involved with forestry activities. Its ongoing activities include a 5-year, $8.7-million AID African Environmental Training and Manage-

ment Project and a 5-year, $20.8-million AID Resource Conservation and Utilization Project in Nepal. The Nepal project involves reforestation, village forestry, introducing more efficient wood stoves, establishing agroforestry research and demonstration facilities, and training and upgrading Nepali forestry and natural resource personnel.

New York Botanical Garden, Bronx, N.Y.

The New York Botanical Garden is owned by the city of New York and is an internationally recognized center for research in the plant sciences. The garden has an annual budget of over $10 million and a staff of about 350 scientists, horticulturalists, other professionals, and support staff. A significant portion of the garden's substantial resources is devoted to activities related to tropical forest flora. The garden's primary commitment is to taxonomic research, much of it in tropical forest areas, especially in Latin America.

The garden's herbarium contains one of the world's largest and most important collections of neotropical plants (mostly from tropical forest areas), and is often consulted about food and natural resource programs in the tropics. The library holds over 600,000 items and is the largest botanical and horticultural collection in the United States.

In 1981, the garden adopted a master plan for its future activities. Of particular significance is the proposed creation of an Institute of Economic Botany which would investigate little known plants used by subsistence societies (often in tropical forest areas) and identify those species with potential for domestication as agricultural crops. The Institute also would investigate and develop species that would have potential as energy sources, particularly species with fast growth rates and those that produce wood of high calorific value.

Arnold Arboretum, Harvard University

The Arnold Arboretum contains over 4 million specimens. The arboretum herbarium and library are especially rich in collections concerning the woody plants and trees of tropical Asia and the Far East. With a staff of 57, it is a leading institution in the Western Hemisphere for the study of Asian tropical botany.

The Arnold Arboretum is an important member of a community of museums and other institutions that comprise the Department of Organic and Evolutionary Biology of Harvard University. As a university research facility, the work of the arboretum is focused primarily on systematic and population biology, essential for providing the basic knowledge of tropical ecosystems on which applied research can be based.

Pacific Tropical Botanical Garden, Lawai, Kauai, Hawaii

The Pacific Tropical Botanical Garden is the Nation's only privately supported tropical botanical garden chartered by Congress. The charter (Public Law 88-449) was granted in 1964 and provides for the establishment of a nonprofit corporation "for the benefit of the people of the United States . . . . in the form of a tropical botanical garden or gardens, together with such facilities as libraries, herbaria, laboratories, and museums which are appropriate and necessary for encouraging and conducting research in basic and applied tropical botany;" which will "foster and encourage fundamental research with respect to tropical plant life and . . . . encourage research and study of the uses of tropical flora in agriculture, forestry, horticulture, medicine, and other sciences . . . . "

The garden has a special role because Hawaii has the greatest number of identified endangered species (800) of any locality on Earth;

most of these species are tropical forest related or dependent.

The garden's 186-acre headquarters site in the Lawai Valley, Kauai, was opened in 1971. The garden maintains two satellite sites, Kahanu Gardens (120 acres) on the island of Maui, and the Limahuli Valley Satellite garden and Preserve (1,000 acres) on Kauai. The Kahanu site is the center for ethnobotanical plants and breadfruit, coconut, and loulu palm collections. The Limahuli Valley site contains newly discovered species of rare native Hawaiian plants. The garden has plans to develop extensive collections of plants of nutritional value, ethnobotanical interest, medicinal value, rare and endangered species, plants of unexploited potential, tropical fruits, spices, and a number of special collections. The garden also has access to the facilities of the Department of Botany of the University of Hawaii and is constructing extensive laboratory, library, and herbarium facilities.

The garden has about 21 full-time staff at its headquarters in Lawai, 4 staff at Kahanu, and 2 at Limahuli. The budget for fiscal year 1982 was approximately $750,000.

Missouri Botanical Garden, St. Louis, Mo.

The Missouri Botanical Garden is a private, independent institution and is the second oldest botanical garden in the United States. The garden is one of the leading, and most active, botanical institutions in the world. With over 3 million specimens, it has this country's fourth largest herbarium. The herbarium is particularly strong in collections from the Neotropics and is also the U.S. national center for African collections.

Of total operating expenses for fiscal year 1981 of $4.3 million, approximately $650,000 were spent on tropical research. As of July 1982, the garden had nearly $2 million worth of grant support for ongoing tropical research. Many projects, of course, continue over a duration of several years. Almost all of this support was from NSF.

The herbarium has 14 Ph. D.-level botanists on its staff, and the library of the garden has one of the finest collections in systemic biology in North America. The Missouri Botanical Garden is also one of the leading centers for education of plant scientists in North America.

Volunteers in Technical Assistance (VITA), Arlington, Va.

VITA is a nonprofit organization with a membership of over 4,000 technical specialists who volunteer or sell their services to help resolve technical problems in developing countries. Seventy-five of these specialists have training and experience in forestry. As of May 1982, however, VITA had no current programs directly concerned with sustaining tropical forest resources. In the past, VITA professionals have participated in a number of forest related programs, such as agroforestry and integrated farming projects. VITA is an important source of information—e.g., their publication "Wood-Conserving Cooking Stoves."

World Wildlife Fund-United States (WWF-US), Washington, D.C.

WWF-US is the principle private source of U.S. funding for the conservation of living resources worldwide. In 1980, WWF-US spent some $2.9 million on more than 100 projects all over the world. The largest single WWF grant in 1980 was $116,000 for study of tropical forest ecosystems in Brazil with the goal of determining the minimum size necessary for protected areas to sustain rainforest plant and animal species. Other WWF-US projects concerned with tropical forests involved funding a forest biosphere reserve in Honduras, training and conservation education in tropical countries, conservation of endangered primates in Brazil and Sierra Leone, funding two U.S. NGOs active in promoting conservation of tropical forests, and promoting the *World Conservation Strategy.*

National Wildlife Federation (NWF), Washington, D.C.

NWF is the largest conservation organization in the Western World. It has more than 4½ million members and a budget of over $27 million annually. Until recently, however, its emphasis was almost exclusively domestic. In 1982, NWF initiated its international program. This new program focuses on three activities: investigating the policies and actions of the United States that affect management of natural resources in developing countries; assisting conservation NGOs in Latin America and the Caribbean; and public education efforts in the United States to explain the relationship between resource problems at home and abroad.

Sierra Club, International Earth Care Center, New York, N.Y.

This section of the Sierra Club is an information clearinghouse and educational resource center with the objective of providing information on the environmental implications of development decisions. The center has three areas of focus: protection of fragile natural areas, the marine environment, and tropical rainforest management and conservation.

In 1974, the center carried out a UNEP-supported project to develop guidelines for the rational management of tropical forest resources in Venezuela. This served as the basis for a series of training workshops in that country for government employees and conservationists. The center is promoting plans for mangrove management and conservation in Venezuela, Trinidad, and Tobago. It had a fiscal year 1982 budget of $350,000 (30 percent for tropical forest efforts) and seven staff.

CARE, New York, N.Y.

CARE is an important development aid private volunteer organization (PVO). In 1981, CARE provided overseas assistance valued at over $250 million. Of this, 83.6 percent was for food distribution and 13.9 percent was for technical assistance, mainly health and village infrastructure projects. However, there were projects for tree planting, erosion control, and conservation in Guatemala, Columbia, Indonesia, and Niger.

CARE is now engaged in a 3-year (1982-85), $5.4-million program to conserve renewable resources (forests, soil, and water) in the developing world. Half of this program is financed through an AID matching grant. The CARE renewable resources program focuses on village and community forestry to promote economic self-reliance. It involves creating shelterbelts and fuelwood lots in arid lands, planting trees to control erosion in hill lands, and transferring agroforestry techniques. Projects are planned for 11 countries (Guatemala, Honduras, Niger, Cameroon, Mali, Sudan, Kenya, Nepal, Haiti, and two yet to be identified). Although only a small part of CARE's total budget, their efforts to promote conservation of forests and forest dependent resources in the tropics is the largest ongoing program of any PVO in the United States.

The Nature Conservancy, International Program, Leesburg, Va.

The Nature Conservancy is a nonprofit, private conservation organization whose goal is to preserve natural diversity by setting up protected areas in the United States and abroad. The Nature Conservancy owns the largest system of privately managed natural areas in the world, about 700 preserves totaling nearly 500,000 acres. The conservancy has a large domestic program, with expenditures over $69 million in 1981. Of their 226 domestic projects, two or three are in Florida and could be considered to involve tropical forest resources.

The Nature Conservancy's smaller International Program, on the other hand, is chiefly concerned with promoting the inventory and protection of natural areas, principally tropical forests, in Latin America and the Caribbean. The International Program has a full-time staff of eight and a 1982 project budget of $387,000.

The International Program hopes to promote **private** institutional land-saving capacity on a country-by-country basis in Latin America. As

a first step, it has established or is establishing cooperative relationships with national conservation organizations in Costa Rica, Ecuador, the Netherlands, Antilles, Venezuela, Mexico, and Argentina. The conservancy hopes to modify and transfer its domestic "Natural Heritage" ecological inventory methodologies to selected Latin American organizations and assist these organizations technically and financially in acquiring biologically significant natural areas from local landowners.

Rare Animal Relief Effort (RARE), New York, N.Y.

RARE is a nonprofit, nongovernmental organization dedicated to preserving biological diversity, especially in the tropics. RARE's primary commitment is to environmental education and training in Latin America. It is undertaking a Resource Management Education Program in which RARE staff and faculty from several universities in Costa Rica and the United States are preparing environmental teaching materials (with an emphasis on the importance of tropical forests) for use in primary schools in Latin America. RARE seeks to promote public environmental awareness in the developing world and has helped to design education centers in Costa Rican national parks.

RARE is a newly formed organization and depends on corporate and foundation support. In 1982, it had four full-time paid staff members and a budget of about $200,000. RARE relies heavily on volunteer assistance by qualified professionals.

East-West Center, Honolulu, Hawaii

The East-West Center was established by the U.S. Congress in 1960 to promote better relations among the peoples of Asia, the Pacific, and the United States. The Center is a nondegree-granting graduate research institution concerned primarily with problems of population, natural resources, environment, culture, and communications. Most of the tropical forest resource programs are conducted under the auspices of the Environment and Policy Institute, one of five institutes within the Center.

The Environment and Policy Institute (EPI) is involved in a number of information transfer and dissemination projects concerning tropical forest resources—principally workshops, training seminars, and preparation of state-of-the-art handbooks and bibliographies. EPI's focus is on forest watershed systems, agroforestry (in cooperation with CATIE, ICRAF, and the U.N. University), fuelwood systems, and mangrove forests.

The Center has a unique role as a regional center for the discussion and study of natural resource issues of Pacific Basin countries. For example, in August 1982, the Center sponsored a meeting of the national forestry research institute directors of 16 countries in the region. The Center also has conducted a number of workshops and seminars to strengthen regional forestry institutions and upgrade the training of forestry personnel.

The Center plays a significant role in promoting forest resource research in the Pacific region through its fellowship, internship, and professional associate programs. A total of 1,500 people take part in such academic support programs each year, and a considerable number of them are involved directly or indirectly in disciplines related to sustaining tropical forest resources.

The East-West Center has a permanent staff of 250, and of its fiscal year 1982 budget of $21.3 million, $164,000 was devoted to tropical forestry research. Nearly 90 percent of the Center's support comes from the U.S. Government, but contributions from countries in the Pacific Basin have been increasing in recent years.

Natural Resources Defense Council (NRDC), International Project, Washington, D.C.

NRDC is a nonprofit, tax-exempt organization dedicated to the wise management of natural resources. NRDC has approximately 45,000 contributing members in the United

States and abroad and has a professional staff of over 40 lawyers, scientists, and other specialists.

NRDC's International Project has been actively involved in activities concerned with the conservation of tropical forest resources. The International Project works in two areas. First, NRDC monitors decisions of U.S. and international agencies affecting tropical forest ecosystems. Second, NRDC cooperates with and makes its expertise available to foreign environmental scientists and groups.

The International Project serves as the secretariat of a U.S. Nongovernmental Working Group on Tropical Forests which consists of over 100 individuals from over 50 different institutions. The Working Group worked closely with the U.S. Inter-Agency Task Force which formulated a U.S. strategy to deal with tropical deforestation.

DEVELOPED WORLD INSTITUTIONS

Canada

Canadian International Development Agency (CIDA), and the International Development and Research Center (IDRC)

A substantial portion of CIDA forest projects is concerned with developing forest industry infrastructure—e.g., building sawmills, purchasing lumbering equipment, training forest industry technicians, etc. From 1976-82, about 38 percent of total funding for projects with a forestry component was for projects with a forest industry development component. Moreover, most of the other projects characterized as nonindustry activities were at least indirectly related to forest industry development—e.g., technical, planning, and inventorying assistance related to exploiting forest resources.

Some 43 percent of CIDA projects with forestry components are in French-speaking Africa, especially the Sahel. Some of these projects are oriented towards sustaining tropical forest resources, including a $40 million antidesertification project for Upper Volta, scheduled to be implemented from 1982-87. Generally, however, there is a lack of emphasis on long-term conservation of forest resources in the financing of many CIDA projects. CIDA Forestry Sectorial Guidelines do, however, contain a number of well-formulated suggestions concerning the need to allocate funds for innovative forestry development projects even if they will not show a conventional satisfactory rate of economic return over the first 10 to 12 years. In particular, the guidelines suggest that CIDA take initiatives in pioneering afforestation projects in degraded forest areas. The guidelines suggest that Food for Peace programs would be an especially appropriate means for implementing such programs. The guidelines also recommend increased emphasis on research and implementation of agroforestry systems.

Tropical forestry resource research is carried out by a separate agency, IDRC. The major focus of the IDRC research is to support studies concerning increased agricultural production using agroforestry systems. Other research is directed towards social forestry in tropical zones.

France

Centre Technique Forestier Tropical (CTFT)

In France, forestry projects for CTFT are financed and implemented by le Fonds d'Aide et de Cooperation (FAC), the Caisse Centrale de Cooperation Economique, and the Bureau d'Études Techniques. FAC has an annual budget of 1 billion francs ($167 million), of which 20 million francs ($3.3 million) goes for forestry-related technical assistance, mainly in French-speaking African countries. The Caisse Centrale de Cooperation Économique spent 43 million francs ($7 million) in 1979 and 16 million francs ($2.7 million) in 1980 on forestry projects in Africa.

The Bureau des Études Techniques (BET) of CTFT is the implementation branch of what is otherwise a research institution. BET has a staff of 9 (3 professionals) in France, and 30 overseas (8 professionals). In 1980, it had a budget of 17 million francs ($2.8 million), 60 percent of which was spent on plantation operations run or assisted by CTFT, 23 percent on planning forest resource inventories and studies of various kinds, and most of the rest on fishery and pisciculture development. Eighty-seven percent of the activities of BET were in Africa.

For 1980 (the last year for which a detailed research report is available), CTFT activities concentrated on improving plantation silviculture, with particular emphasis on tropical pines and *Eucalyptus* trees. Other activities included studies of forest ecosystem transformation in French Guinea caused by different land use patterns, research concerning reforestation possibilities in the Sahel, and consolidation of a tropical forest gene bank at CTFT headquarters.

France is losing its skilled tropical forestry professionals through attrition. About 16 or 18 members of the former overseas colonial forestry corps (corps d'ingenieurs des eaux et forêts d'Outre Mer) will be retired by 1986. The remaining handful of professionals with tropical forest expertise are associated with the École Nationale du Génie Rural des Eaux et des Forêts, and with the École Nationale des Ingenieurs des Travaux des Eaux et Forêts.

Japan

Japanese Overseas Afforestation Association (JOAA), Tokyo, Japan

JOAA was established by 11 paper and pulp companies in Japan. JOAA is engaged in promoting trial plantations, generally of exotic species, in tropical East Asia. It is engaged in evaluating the viability of various afforestation and reforestation techniques, with a primary goal of ensuring future pulp supplies. In the words of one AID document, "JOAA feels strongly that there needs to be formed a worldwide afforestation/reforestation organization and center to coordinate and conduct trial plantations in all of the tropics" (14).

Sweden

Swedish International Development Authority (SIDA)

SIDA is active in tropical forest resource related projects in nine especially poor countries: Ethiopia, Guinea-Bissau, Mozambique, Zambia, Lesotho, Tanzania, India, Bangladesh, and Laos. The emphasis of Swedish bilateral projects is oriented as much towards development of the infrastructure for forest industries as towards sustaining forest resources. Such development includes construction and improvement of forest roads, pulp and paper mills, and sawmills. However, other project components include reforestation and afforestation, soil conservation, and training of forest wardens and personnel.

More recently, SIDA has become concerned with the fuelwood crisis in Africa and Asia. To address this problem SIDA is increasing its collaboration with FAO with respect to village and community forestry.

United Kingdom

Overseas Development Administration (ODA)

ODA is active both in financing research related to sustaining tropical forest resources and in technology transfer through its Land Resources Development Centre (LRDC). About 1 percent of the ODA budget for bilateral aid is for forestry studies. ODA's total expenditure on forestry research for 1981-82 was about 440,000 pounds ($250,000). In addition, ODA provides the core funding for the Commonwealth Forestry Institute (see separate listing).

ODA's forestry research focuses on genetic improvement of selected tropical species and traditional silviculture. As of 1980, at least half of the total forestry research funding was devoted to improving various species of Central American and Mexican pines.

The LRDC division of ODA is involved in activities related to implementing and transferring agricultural and forestry development technologies. In particular, LRDC offers technology transfer services in forest resource evaluation, forest management and planning, and pilot development projects. LRDC has a staff of 60 scientists including specialists in tropical soil science, ecology, hydrology, irrigation engineering, agriculture, land use planning, economics, and sociology. LRDC had six forestry experts on its staff in 1982.

Intermediate Technology Development Group (ITDG)

ITDG is a nonprofit organization formed in 1965 by the late E. F. Schumacher to give information and advice on appropriate technologies for developing countries. ITDG has a staff of about 60 and is assisted by nearly 300 voluntary experts who provide advice in many fields, including forestry and forest industries. Two organizations within ITDG are of special relevance to sustaining tropical forest resources: Intermediate Technology Industrial Services (ITIS) and Intermediate Technology Consultants Ltd.

ITIS is involved in alternative energy development studies and projects which, when implemented, could lessen the pressures on tropical forests. ITIS is at work on a project to develop and introduce more efficient fuelwood stoves in Indonesia, Nepal, and Sri Lanka.

Intermediate Technology Consultants Ltd. has an Appropriate Technology for Forestry (ATF) branch. This is a consultancy service to provide an integrated approach to forest development using intermediate and small-scale technology. ATF has special expertise in social forestry, creating village woodlots, and designing and developing fuel-efficient systems for cooking and power generation.

Institute for Terrestrial Ecology

The Institute has eight research laboratories in the United Kingdom, one of which, the Penicuik Station, has worked since 1974 on a project concerning the reproduction, conservation, and improvement of tropical hardwoods. This project was funded by the U.K. Overseas Development Administration in cooperation with the West African Hardwood Improvement Project of the Forestry Research Institute of Nigeria. Attention has been given to the West African hardwood *Triplochiton scleroxylon* with respect to techniques for vegetative propagation, the management of stockplants, the selection of superior clones through a study of branching processes, and the stimulation of precious flowering and seed production. These studies are of importance for the propagation and conservation of other tropical trees, since already 37 other species in moist and arid zones have been found to respond to techniques developed for *T. scleroxylon.*

Commonwealth Forestry Institute, Unit of Tropical Silviculture

The Commonwealth Forestry Institute consists of the Department of Forestry of Oxford University, its library, and the Commonwealth Forestry Bureau. The Unit of Tropical Silviculture of the Oxford Forestry Department is engaged in research and training in tropical forestry and is the main center for such research in the United Kingdom.

The unit's program is directed toward helping tropical forest countries obtain increased and sustained outputs of wood. Particular attention has been given to the use of degraded sites, cutover areas, or land unsuitable for permanent agriculture. Recent research in genecology, taxonomy, and variation has been directed to promote plantations of fast-growing tree species such as Central American pines.

The unit's staff includes 13 professional research officers, 3 research assistants in computing and training, 5 technicians, and a clerical staff of 4. In 1980-81, total expenditures were 361,311 pounds (approximately $206,500).

West Germany

Bundesministerium für Wirtschaftliche Zusammenarbeit (BMZ), and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

The West German Federal Ministry for Economic Cooperation (BMZ) funds German development aid projects. Forestry projects are implemented by the German Agency for Technical Cooperation (GTZ). Out of 494 field staff in agriculture and forestry, GTZ has 21 university trained forestry and timber experts and 9 technicians. In addition to its staff, GTZ relies on German universities and especially on the German Public Forestry Administration for technical support. GTZ forestry professionals are concentrated heavily in Africa, where 18 of the forestry field staff of 30 work. Nine staff members work in Asia, and three in Latin America.

GTZ forestry policy has three priority areas: forest conservation and production; institution building; and forest industries, timber technology, and processing, whose goal is increasing the efficiency of forest and timber industries.

DEVELOPING WORLD INSTITUTIONS (ASIA, AFRICA, LATIN AMERICA)

Brazil

A comprehensive description of Brazilian institutions concerned with sustaining tropical forest resources would be an enormous task. This section only describes some of the major institutions, focusing on those that promote a more innovative and ecologically oriented approach to research and implementation.

In 1980, the Brazilian Government published a comprehensive listing of ongoing forestry research projects in the country. This compendium listed 1,365 projects, of which 1,119 involved silviculture, 61 environmental and ecological research, 63 forestry administration, and 123 forest industry technology. The single most important area in silviculture research concerned genetic improvement of species (mainly plantation type trees such as eucalyptus and pine) with 598 ongoing projects.

Principal institutions undertaking ongoing research were the Instituto de Pesquisas e Estudos Florestais in Piracicaba, Sao Paulo state, and the Instituto Brasiliero de Desenvolvimento Florestal (IBDF), Brasilia, and most important for the purposes of our study the Empresa Brasiliera de Pesquisa Agropecuaria (EMBRAPA) (Brazilian agricultural research enterprise). IPEF's work mainly involves traditional plantation silviculture.

IBDF works closely with EMBRAPA. IBDF is principally an administrative and financing agency, while EMBRAPA actually undertakes and implements national forestry research.

A 1980 project, Agricultural Research II (AR II) calls for a $7.62-million forestry research program that will concentrate on agroforestry and the use of marginal, degraded land for forestry. This program is an innovative departure from the emphasis of most previous forestry research programs in Brazil on traditional plantation silviculture. The agroforestry research will focus on the potential of taungya systems, agroforestry systems using medium cycle and perennial crops (coffee, cacao, palmito, ipecacuanha, etc.), and forestry-livestock combinations.

The marginal land forestry research will focus on rehabilitating and reforesting ecologically degraded areas near Brasilian population centers, particularly in the overpopulated and deforested northeast.

EMBRAPA has a total professional research staff of 34, with 124 technical support personnel. The AR II plan will add 14 more scientists to the professional staff, for an eventual total of 48.

The Forestry Research Unit of the Agricultural Research Center for the Semiarid Tropics

(CPATSA) at Petrolina, Pernambuco state, is addressing the problem of reforestation and afforestation of Brazil's most ecologically degraded, poorest, and densely populated region —the Northeast. This area is now principally covered by a sparse, brushy type of vegetation known as "caatinga." CPATSA is undertaking ag.oforestry experiments to identify and propagate tree species with high wood and forage yields. Research is also under way on genetic improvement of species suitable for fuelwood and charcoal production.

Other institutions involved with sustaining tropical forest resources include a number of Brazil's 57 universities and 803 institutes for higher learning. Three universities in particular have strong programs in natural resource and forestry management: the Universidade Federal de Parana, the Universidade Federal de Vicosa em Minas Gerais, and the Escola Superior de Agricultura 'luiz de Quieroz' in Piracicaba, Sao Paulo state.

Instituto Nacional de Pesquisas da Amazonia (INPA)

INPA, another Brazilian institution, is one of the most important developing country research institutions dealing exclusively with tropical forest resources and their sustainable management. INPA has over 700 staff, more than 140 of whom are university trained researchers. It is divided into eight departments: ecology, tropical pathology, tropical silviculture, botany, natural products, limnology, and aquatic biology, technology, and agronomic sciences.

The Department of Ecology has studied the physical and chemical environment of Amazonian organisms, with emphasis on regional water, carbon and mineral cycles, and energy budgets and on the systematics and ecology of insects. The Department of Pathology has focused attention on parasite and disease vectors in the Brazilian Amazon, and the Tropical Silvicultural Department is devoting much of its resources to a project entitled "Ecological Management and Exploitation of Moist Tropical Forests," with special emphasis on natural regeneration. Among the most important projects of the Department of Botany is the "Amazonian Flora Project," a species inventory supported by NSF of the United States. With NSF support, 11 binational expeditions were conducted from 1977 to 1980 in different biotic areas of the Amazon Basin by Brazilian and American researchers, resulting in the gathering for herbarium collections of about 25,000 different species of organisms.

The Department of Natural Products is carrying out unique research on the chemical and pharmaceutical properties of tropical forest organisms in the Amazon. Particular attention is being focused on plants possessing biologically active alkaloids, plants used by various Indian groups for their contraceptive properties, and little known fruits and vegetables that appear to be rich sources of vitamins and proteins.

The Department of Aquatic Biology and Limnology focuses mainly on systematic characterizations of Amazonian fish species and limnological data on lakes and rivers in the region, with special attention given to aquatic macrophites and their potential use as fertilizer and cattle food. The technology department is concerned with research relating to the possible industrial uses of wood and fibrous materials from the region, especially for pulp and paper production. Finally, the Department of Agronomic Sciences is focusing on genetic improvement and intercropping systems for fruit trees and the following species: peach, palm, soursop, cupuacu, South American sapote, uvilla, araca-boi, araca-pera, camu-camu, and lacuma. Research on erosion control, conservation, and nitrogen fixation in Amazonian aquatic plants and termites is being conducted by the Department's Division of Soils, and the Division of Alternative Energy Sources is developing projects concerning the use of river currents for energy production, biogas, and charcoal gases.

INPA is also a graduate and postgraduate educational institution. From 1974 to 1981, it produced 54 graduates at the Master's level and four Ph. D.s. Courses are offered in forest man-

agement, botany, ecology, entomology, and freshwater biology and fisheries.

Cameroon

The Ministère d' Agriculture (MINAGRI) in Yaounde is responsible for all activities in the forestry sector. Within MINAGRI, the Direction des Eaux et Forêts et des Chasses oversees replanting programs and the management of state forests. The Fonds National Forestier et Pisicole manages an inadequate reforestation program of 2,500 ha per year. Forestry research is undertaken at the Institute de la Recherch Agronomique, and the École Nationale Superieure Agronomique at Nikolbisson provides forestry training at the technical level. There is a school for training wildlife specialists (École pour la Formation des Specialists de la Fauve) in Garoua. It is affiliated with FAO and the College of African Wildlife Management in Mweka, Tanzania.

Ghana

The principal institutions in Ghana concerned with implementing technologies to sustain tropical forest resources are the Forestry Department (FD) and the Forest Products Research Institute (FPRI). FD is a constituent department of the Ministry of Lands, Natural Resources, Fuel, and Power and is responsible for the management of forest reserves and resources. As of 1979, FD had a staff of 24 forestry professionals, 133 senior technical officers, 387 technical assistants, and 1,316 forest guards.

FPRI is one of the most important forest resource institutions in West Africa. It conducts basic and applied research concerning, among other things, natural regeneration of the tropical high forest, agrosilviculture, and protection of seedlings against fungi and weevils. As of 1980, FPRI had a staff of 32 professionals, 22 senior technicians, 80 junior technicians and field assistants, and 466 tradesmen and laborers.

Management and efficiency of FD and FPRI have deteriorated over the past decade. The professional staff is good, but political problems exist. Another constraint is a shortage of sufficiently experienced staff (less than 80 percent of established professional posts are filled), inadequate facilities, and the lack of a professional level forestry school.

Lack of effective coordination among government forestry agencies has been helped by the World Bank and FAO, which created a Forestry Commission in 1980. Its task is to coordinate and integrate the functions of FPRI, FD, the Department of Game and Wildlife, and the Ghana Timber Marketing Board.

Indonesia

Responsibility for forestry is divided between the Directorate General for Forestry (LPPH-Lembaga Pusat Penelitian Hutan), which oversees national forest policy and planning, and 27 Provincial Forest Services (Dinas Kehutanan), which are directly responsible to the governors of the respective provinces. In addition, forestry activities in the three heavily populated provinces of Java are managed by the State Forestry Corporation, Perum Pertrulani. As a consequence of this institutional fragmentation, coordination in forestry planning is lacking. The provincial forest services are important institutions, since they have direct authority to manage most of Indonesia's remaining forest resources.

The most important institution involved in conserving Indonesia's forest resources is the Directorate of Nature Conservation (PPA). PPA has received substantial aid from FAO, UNEP, and WWF to develop management plans for 24 protected areas covering 6.8 million ha (out of a total of 77 legally established areas with an area of 8.7 million ha). The Directorate General of Forestry plans to implement five of the management plans in 1982. Despite this ambitious program, PPA will have difficulty preserving even a proportion of these reserves.

Indonesia has a substantial and growing grass roots environmental movement, much of whose concern is directed towards deforestation. Seventy-nine of these groups have formed

a national coalition known as the Indonesian Environmental Forum, which receives some assistance from a recently formed (1978) State Ministry for Development Supervision and Environment (Menteri Negara Pengawasan-Pembangunan Dan Lingkungan Kidup). This Ministry is involved in preparing environmental assessments and in integrating environmental considerations into the state's economic development plans.

Ivory Coast

The principal forestry institutions in the Ivory Coast are the Ministère des Eaux et Forêts, which includes the Direction des Parcs Nationaux and the Société pour le Développement des Plantations Forestieres (SODEFOR) (State Company for the Development of Forestry Plantations). SODEFOR is responsible for reforestation and management of national forests. However, in its first 10 years (1966-76), only 15,000 ha were reforested.

There is no university level forestry training, but there are forestry technical schools at Bouake and Banco which offer 2-year training courses. Although the Banco Forestry School was founded in the 1930's, relatively recent reports (1979) state that it is in a state of neglect and lacks equipment.

Liberia

The Forest Development Authority is responsible for the administration of national forest areas, forest and land use policies, and research and forestry training. The Forestry Training Institute in Boni Hills provides technical staff training for about 20 Liberians and 5 Sierra Leonean forest rangers per year. The College of Agriculture and Forestry in the University of Liberia graduates four to six professional foresters a year.

Malaysia

Malaysia is a federation of 14 states, 12 in peninsular Malaysia, and 2, Sabah and Sarawak, on the island of Borneo. Institutions involved in forestry research and management in peninsular Malaysia are the best financed and most professionally competent in Southeast Asia; Sarawak and Sabah, where most of Malaysia's remaining tropical forest resources are located, are less developed.

The Malaysian constitution makes forest resource management the responsibility of the state governments. There is a Federal Forestry Department in the Federal Ministry of Primary Industries, but only the states in peninsular Malaysia recognize its authority. Forestry administration is autonomous and separate in Sarawak and Sabah. As of December 1980, total forestry staff in peninsular Malaysia was about 5,600, nearly 5,000 of whom were with the state forest departments. There were 280 professional level staff.

The Forest Research Institute (FRI) at Kepong, while technically the national forestry research institution, is actually the research institute for peninsular Malaysia. FRI has a substantial international reputation. It has been a leader in research into sustained yield management of mixed dipterocarp forest.

The FRI library has over 100,000 volumes and is the most comprehensive forestry library in Southeast Asia. In addition, FRI has a herbarium with 120,000 specimens. FRI has a staff of 400, with about 80 professional positions. A major institutional problem is the low pay and resulting short tenure of staff members, who try to move on to better paying positions in the Federal Forestry Department as quickly as possible.

Training in forestry is provided at both the professional and technical levels. The Agriculture University of Malaysia, at Serdang, has 4- and 3-year diploma courses in forestry and produces about 60 graduates annually. The university has extension courses and seminars, but research is limited and underfunded. A major institutional problem is the lack of contact and exchanges between the forestry faculty members and their colleagues in other Southeast Asian countries and the rest of the world.

In Sarawak, forest resources are administered by the Forestry Department (FD) and the Sarawak Timber Industry Development Corp.

(STIDC), both of which are part of the Sarawak Ministry of Forestry. In 1980, FD had a staff of about 1,000, 80 of them senior level professionals. FD has a forestry research staff of 130 (15 professionals) whose main interest is the silviculture of the mixed dipterocarp forest.

The Sabah Forestry Department (FD) is part of the Sabah Ministry of Natural Resources. Located at Sandakan, it has a staff of about 1,000, with 60 senior level professionals. The FD also has responsibility for game and wildlife affairs and maintains an orangutan rehabilitation center at Sepilok.

The Sabah Foundation owns all government land in Sabah and thus in some respects is the most important forest resource institution in Sabah, since it has title to much of the remaining forested areas. The Sabah Foundation is engaged in an agressive program of conversion of forested lands for agricultural development.

Mexico

Unlike many nations in Latin America, Mexico possesses an active scientific community that has become increasingly concerned about the ecological costs of economic growth, including the effects of development on tropical forest resources. Reflecting this concern, President Luis Echeverria (1970-76) encouraged the National Council for Science and Technology to create or expand a number of specialized research facilities throughout the country. The three most important with respect to tropical forest resources are the Instituto Nacional de Investigaciones Forestales in Mexico City, the Instituto Nacional por Investigaciones sobre Recursos Bioticos in Jalapa, Veracruz, and the Instituto Nacional de Ecologia in Mexico City.

During the past 5 years, forestry research in Mexico has increased by 100 percent; the number of professionals working in tropical areas has grown from 2 to about 30. The National Institute of Forest Research operates nine regional research centers, of which three are concerned with tropical moist forests: Campeche (covering the states of Campeche, Quintana Roo, and Tabasco), Oaxaca (Oaxaca, Guerrero, Chiapas) and Veracruz (Veracruz and the northern gulf coast). Although research priorities vary among these facilities, the Institute maintains eight major programs: forest management (including silviculture research for sustained yield); forest protection, forest plantations (both for industrial and protective ends), forest products research (including optimal use of forest resources), surveys and planning, multiple use of forest resources (e.g., agroforestry and other mixed crop systems), methods of harvesting and extraction, and wildlife and protection of endangered species.

The National Institute for Research on Biological Resources (INIREB) has 70 professional research staff. INIREB focuses on applied research to develop appropriate technology for ecologically sustainable development. A second priority is basic research. INIREB has the most extensive research program concerning tropical forest resources in Mexico and one of the most important in Latin America. It also conducts training courses for research scientists and extension courses for peasants and fishermen.

The Institute has an innovative research program to develop ecologically sustainable agricultural systems with increased productivity. It has a special interest in *chinampas,* mixed cropping for coffee production, agroforestry, and aquaculture.

The National Institute for Ecology (Instituto de Ecologia) is affiliated with the National Museum of Natural History. For 1981-82, the Institute had 11 projects. Five projects involved research, planning, and development of ecological or biosphere reserves. Biosphere reserves are part of a global network of protected representative ecosystems under the UNESCO Man and the Biosphere Program Project 8. They have had varying successes in Mexico—from being virtual legal fictions, in the case of the Lacandon rainforest in southeastern Mexico, to relative effectiveness, as with the Mapimi Biosphere Reserve in the desert area of Durango state. The key factor in the success or failure of protected areas in Mexico has been the degree of support and participation that has been elicited from local farmers and ranchers.

The 1982 budget of the Institute is about 90 million pesos, or approximately $1.8 million at the July 1982 exchange rate.

Nigeria

Nigeria is a federation of 19 states, and the State Forest Services have the direct responsibility for the actual management and protection of forest reserves. These constitute 10 percent of Nigeria's land surface. The Forest Service of each state is usually within the Ministry of Agriculture and Natural Resources and is headed by a Chief Conservator of Forests. As of 1978, budget expenditures for the State Forest Services were 400 percent greater than the total federal forestry budget.

The Federal Department of Forestry is a department of the Federal Ministry of Agriculture and Water Resources. It formulates national forest policy and monitors state forestry activities.

The Forest Research Insitute of Nigeria (FRIN) in Ibadan is an important forest research facility. FRIN has a library of over 37,000 items and 900 permanent staff, of which more than 80 are senior level forestry professionals. FRIN has nine divisions, five directly concerned with sustaining tropical forest resources: the Tree Crop Production Division (which conducts research in Agrisilviculture), the Soil and Tree Nutrition Division, the Forest Pathology Division, the Ecology Division, and the Education and Training Division.

The University of Ibadan has a forestry department which graduates about 70 professionals a year. It serves as the professional forestry school for most of English-speaking West Africa, including Ghana. In addition, there are two vocational Forestry Schools that train 300 forest technicians a year. As in other West African countries, however, there is a scarcity of trained manpower, and 20 to 60 percent of the established federal and state forestry posts at different levels are unfilled.

Papua New Guinea

The Wau Ecology Institute is dedicated to ecology and conservation education and research. Located in the mountains of eastern Papua New Guinea, it has an arboretum of native plants, a zoo, a small museum, and some research facilities. The Institute receives funding from a variety of foreign governmental and nongovernmental agencies.

Since 1976, the Institute has done research to develop gardening systems that could serve as alternatives to present patterns of slash and burn cultivation. Initial efforts involved trying to develop more efficient gardening—using conventional methods such as composting, mulching, crop rotation, etc.—but research revealed that such systems involved greater labor inputs than existing systems and thus had no attraction for indigenous farmers. Present efforts are concentrated on assisting local farmers to make the most efficient use of their land in the context of existing use patterns. In addition, the Institute has embarked on a long-term program to develop agroforestry gardening systems using fast-growing legume trees.

Present staff for the Wau Ecology Institute's agroforestry project includes a director with considerable experience in improving subsistence agriculture systems, four national staff with professional university training, a garden manager, and several laborers.

Philippines

Until 1978, the Bureau of Forest Development (BFD) in the Ministry of Natural Resources had jurisdiction over all government forest lands, including national parks. In 1978, Government dissatisfaction with the stewardship of BFD led to the transfer of all watershed lands (80 percent of the forested areas) to the jurisdiction of the Ministry of Energy.

BFD has a permanent staff of 10,000 employees and in fiscal year 1981 had a budget of ap-

proximately $53 million. But a recent U.S. Forest Service Study states that inconsistency, lack of commitment, and corruption in government agencies that are responsible for forestry greatly diffuse the effectiveness of any long-range forest projects conducted or supported by donor agencies (28). On the other hand, forest research institutions in the Philippines are among the most developed and best managed in tropical East Asia.

The Forest Research Institute (FORI) is at Laguna, near Manila. FORI has a staff of about 2,500, of whom approximately 350 have some technical training. FORI has 24 forestry field research stations and 10 special research centers, including research centers for agroforestry, mangrove management, and dipterocarp management. Also at Laguna is the College of Forestry of the University of the Philippines at Los Banos. It is an institution that is widely respected in East Asia. As of 1981, the Forestry College had 300 students enrolled in its B.S. program, 130 in the M.S. program, and a dozen or so pursuing Ph. D.s.

The Development Bank of the Philippines and the Paper Industries Corp. of the Philippines (PICOP), with assistance from the World Bank, have undertaken over the past 10 years an agroforestry project in Mindanao. This project has been cited as one of the most successful examples of implementation of technology to sustain tropical forests. A key factor seems to be PICOP's efforts to pay attention to the needs of local people and to secure their participation in planning.

Thailand

The Royal Forestry Department (RFD) was founded in 1896 and has responsibility for all forest resource related matters, including research and administration of protected areas. RFD has a staff of 5,860 permanent employees, of whom 3,000 have received some sort of forestry training. Total annual funding for RFD is approximately $250 million a year.

RFD has 12 divisions, including a National Parks Division (staff approximately 180) and a Wildlife Conservation Division (staff approximately 200). The Silviculture and Watershed Management Divisions are engaged in extensive reforestation activities. RFD has 21 regional offices and 71 provincial offices.

The Forestry Industry Organization (FIO) is the other principal forestry institution in Thailand. It has a mandate to promote the controlled exploitation of forests and the development of the forest industry. The Reforestation Division of FIO is working closely with RFD in an extensive nationwide reforestation program whose eventual success or failure will have implications for similar programs elsewhere.

A major constraint for conserving forest resources in Thailand has been the fact that all forest land and much farm land is owned by the RFD. As a consequence, local farmers have little incentive to conserve or sustainably manage forested areas.

Disappointing results from such uncoordinated government activities led to the formulation of a new approach to reforestation, one aimed at village forestry that would incorporate anthropological studies, land use planning, and rural development with reforestation and agroforestry. Socially and economically sustainable reforestation is to be accomplished by establishing forest villages in deforested areas, whereby the government provides a social infrastructure (schools, water, electricity) and gives each family 1.6 ha of land to farm in a taungya fashion, intercropping teak seedlings with rice, yams, and various other crops. In addition, small cash bonuses are given for successful maintenance of taungya areas once they are established. The goal is to create an economically viable, self-sustaining village forest community that will have a vested interest in maintaining the taungya forest cover.

Only 48 or so forest villages have been established, each containing no more than 100 families. The goal is to establish 4,500 forest villages over a 25-year period.

Thailand has one undergraduate and graduate level forestry school, the Faculty of

Forestry at Kasetsart University in Bangkok. There are 60 faculty members, 25 with doctorates, and about 100 students a year are graduated.

REGIONAL INSTITUTIONS

BIOTROP, Bogor, Indonesia

BIOTROP (Regional Center for Tropical Biology) was established by the Southeast Asian Ministers of Education Organization (SEAMEO) to help member states (Indonesia, Philippines, Malaysia, Thailand, Singapore, Laos, Viet Nam, and Kampuchea, the latter three being inactive) identify biological problems whose solutions will enhance economic growth. BIOTROP is managed by the administration of the Bogor Agricultural University in Indonesia and many of its 50 staff have full-time jobs on the Faculty of Forestry or elsewhere.

BIOTROP is an information clearinghouse, training center, and research institute in tropical forestry and biology. However, a recent visit by two USFS foresters indicated that little of BIOTROP's $1.3 million total annual expenditures was devoted to research and that its numerous training programs were suitable for technicians rather than university graduates (5).

Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) Turrialba, Costa Rica

CATIE, with a budget in 1979 of over $6 million and a professional staff of over 100 is one of the most important regional institutions in Latin America. CATIE's mandate is to improve the standard of living of low-income, small-scale farmers in the American tropics by conducting research to increase agricultural, animal, and forest production. CATIE uses a multidisciplinary, participatory strategy in its research, including socioeconomic and physio-biological factors.

Most of CATIE's research is directed towards improving annual and perennial crop production systems and towards improving animal production on small farms. Given the important role of subsistence farmers in converting tropical forests, such research is an important component of any strategy to reduce the pressures that are forcing small farmers to clear forested areas.

Another component of CATIE's research is its Natural Renewable Resources Program, which is the part of CATIE's work most directly concerned with tropical forest resources. This program has about 20 staff, including training officers. It is working on management of secondary forests and plantations as appropriate tools for sustainable use of tropical forests. CATIE believes that tropical deforestation is best avoided by settling people on sustained schemes in areas already deforested and that financing long-term reforestation schemes is a major need.

The Natural Renewable Resources Program is also involved in research concerning intensive silviculture of rapid growing species for industrial uses, and with management of watersheds and primary, protected forest areas such as the Rio Plantano Biosphere Reserve in Honduras.

Eastern Caribbean Natural Areas Management Program (ECNAMP) Christiansted, St. Croix

ECNAMP is a cooperative effort of the Caribbean Conservation Association and the University of Michigan's School of Natural Resources with governmental and nongovernmental organizations in the smaller islands of the Eastern Caribbean. ECNAMP conducts research, training, and field projects to strengthen local capacity to manage living natural resources in natural areas.

Of ECNAMP's annual budget of about $175,000, one-third is devoted to activities directly connected with tropical forests; such projects include the design of natural parks management plans, workshops on park planning and ecologically sound development, and the development of conservation strategies for islands in the region. ECNAMP has seven staff members.

International Council for Research in Agroforestry (ICRAF), Nairobi, Kenya

ICRAF sees itself as a "Council with a global mandate to promote, initiate, and support research in developing countries. It is not, however, an institute with an infrastructure and resources to carry out technology generating research on its own. The most efficient way for ICRAF to make a significant research contribution to agroforestry development has therefore been deemed to be by focusing on identifying methods which can be used by field research institutes in developing countries."

ICRAF plans to emphasize agroforestry as a land use system. It hopes to build a multidisciplinary team of scientists who will identify social, economic, and ecological constraints in existing land-use systems and assess the potential of agroforestry technologies to overcome these constraints. The Swiss Development Agency, IDRC, the German Development Agency, and the Dutch Ministry for Development Cooperation have agreed to send senior staff to ICRAF for periods of 2 to 3 years, and other support is forthcoming from AID.

As of April 1982, ICRAF had 13 senior scientists with training and experience in agronomy, horticulture, forestry, economics, anthropology, and other related fields. ICRAF's costs for 1982 are projected to be $2.2 million, rising to $3 million by 1984. Funding for these projected budgets is still lacking.

INTERNATIONAL INSTITUTIONS

World Bank, Washington, D.C., U.S.A.

Along with FAO, the World Bank is the most important international institution implementing technologies to sustain tropical forests. This is not only because of its sizable and growing financial support for forestry projects ($114 million for fiscal year 1981; $600 million in 40 countries from 1978-81) but also because of the considerable multiplier effect that Bank projects have in the developing world. Although loans earmarked for forestry projects represent less than 1 percent of total World Bank commitments, its programs have both positive and negative indirect impacts on tropical forests. In this respect, the role of the Bank's Office of Environmental Affairs (OEA) is crucial, since it can recommend that up to 3 to 4 percent of the funds committed for projects can be earmarked for conservation and environmental protection.

In the past, World Bank forestry projects have focused on plantation monocultures and forest industry development, with much less emphasis on fuelwood production and watershed protection. However, the Bank's 1978 Forestry Sector Policy Paper declared the Bank's increasing concern with the role of forests in rural development (rural forestry) and environmental protection. The policies of the Forestry Sector Paper have as yet not been completely implemented.

The Bank is especially concerned about the fuelwood crisis and plans to increase its already large fiscal year 1981 commitment (44 percent of new forestry loans) to promoting village fuelwood lots and village forestry. A

major constraint for these plans is the lack of institutions in most developing countries to implement village fuelwood programs.

Another Bank forestry priority for the coming years is strengthening forestry institutions and extension services in the developing world. Since 1978, Bank support for forestry research institutions in the tropics has totaled $22.7 million, less than 3 percent of total forestry lending for this period. In 1981, FAO and the World Bank commissioned a study on forestry research needs in the developing world ("Forestry Research Needs in Developing Countries-Time for a Reappraisal"). One of its main recommendations was that more "twinning" exchange arrangements be established between leading forestry institutions in the developed and the developing world (27).

The World Bank employs 14 professional foresters; 10 are based in Washington, 3 at FAO headquarters in Rome, and 1 in India. Only one forester is assigned to Latin America, where more than half of the Earth's remaining moist tropical forests are found.

The Office of Environmental Affairs has a potentially important role because it reviews all projects for negative environmental impacts and identifies potential protected areas. For example, a recent Bank-financed highway construction and agricultural colonization project in Northwest Brazil provided funding to establish three tropical forest protected areas and four ecological stations. The number of Bank projects potentially having direct or indirect negative impacts on tropical forests is far greater than the very small proportion principally oriented towards reforestation or sustainable forest development. Such projects include large-scale hydroelectric schemes, irrigation, agricultural development and colonization projects, and highway construction programs.

Inter-American Development Bank (IDB), Washington, D.C., U.S.A.

IDB traditionally has devoted relatively little attention to the question of long-term sustainable management of Latin America's tropical forest resources. From 1974 to 1981, the most important IDB forestry project involved a series of loans totaling over $180 million for industrial development (construction of roads, sawmills, etc.) of the Olancho Caribbean Pine Forest reserve area in Honduras, the largest remaining reserve of Caribbean Pine in Central America. New forestry loans approved for 1980 totaled $32.6 million. Up to 1980, IDB did not employ any full-time professional foresters; as of 1982 it had hired one.

Although the Bank's forestry policy paper, formulated in 1975 (being revised) talks briefly about questions of long-term sustainable use and conservation of forest resources, the Bank can finance almost any type of project formulated by the member governments.

The Bank has been influenced by recent chánges in FAO and World Bank forestry policies, which now emphasize village forestry, agroforestry, fuelwood projects, and watershed management. Although IDB may give more attention to these aspects of forestry development in the future, it appears that other institutions such as the World Bank, FAO, and AID will be the leaders in formulating a sustainable forest resource development policy.

Asian Development Bank, Manila, Philippines

The Asian Development Bank has prepared two policy documents concerning forestry in recent years. The first, the Bank's 1978 Sector Paper on Forestry and Forest Industries, identified the following priority program areas: development of industrial forestry and plantations, use of hitherto inaccessible forest by logging and development of infrastructure, and institution building. In 1980, the Bank published a position paper on the "Role of Community Forestry in Rural Development in the Asia-Pacific Region" which gave special emphasis to the Bank's role in promoting community forestry for fuelwood needs and environmental protection.

From 1977 to 1982, the Bank granted loans amounting to $60.8 million for six forestry sector projects. Two were for community forestry

in Sri Lanka and Bangladesh, and four were forestry industry development projects in Burma, Laos, Nepal, and Western Samoa. The Nepal and Western Samoa projects had important reforestation components.

Food and Agriculture Organization of the United Nations (FAO) Rome, Italy

FAO has the greatest accumulation of professional tropical forestry expertise in the world. Its Forestry Department employs 62 professionals at headquarters in Rome and about 250 specialists working in 70 countries in the field. Of FAO's total working budget for 1982-83 of $368 million, $14.7 million is allocated for the regular program of the Forestry Department. In addition, some $60 million in extra budgetary funds will be administered by the Forestry Department in FAO's Field Program. These are substantial amounts, but forestry still has a secondary role at FAO. For comparison, the 1982-83 working budget for the Agriculture Department is $127.9 million, with over $475 million in extra budgetary funds.

FAO's forestry activities for 1982-83 are divided into four programs: forest resources and environment, forest industries and trade, forest investment and institutions, and forestry for rural development. The Forestry Investment and Institution Program is the most heavily funded, with a working budget of over $4 million. Components of the program include training and institution building, investment planning and statistics, and development of forest policy and information. The Forest Industries and Trade Program is budgeted at $2.7 million for the next fiscal period and has the goal of promoting and assisting the forest industry sector in developing countries.

Of most relevance to technologies for sustaining tropical forest resources are the Forest Resources and Environmental Program and the Forestry for Rural Development Program, budgeted at $2.38 million and $2.5 million, respectively. The Forest Resources and Environment Program focuses on these objectives: creating a world forest resources information system, expanding forest tree plantations for environmental protection and as renewable sources of energy and food, developing upland forests for erosion control and watershed management, and managing wildlife. To accomplish these objectives, FAO will update the Tropical Forest Resources Assessment that they recently completed for UNEP (see UNEP section), expand the Forest Data Processing System (FIDAPS), promote tree improvement and plantations with emphasis on fuelwood and multiple purpose species, improve upland conservation practices through integrated watershed and forest land development, and promote wildlife and national park policies in the context of national renewable resource management.

The Forestry for Rural Development Program of FAO's Forestry Department plays an innovative role in promoting community forestry and agroforestry, with an emphasis on alleviating the fuelwood crisis in many developing countries. Most of the funding in the FAO Field Program goes for forest management and afforestation, education and training, institution building, and development of the forest industry sector. For 1980-81, forestry projects represented about 11 percent of the FAO Field Program, with expenditures of $60 million out of a total of $561 million. Increased emphasis is being given to community forestry and small-scale forestry industry projects. UNDP supplies about 60 percent of funds for FAO field projects in general and nearly all UNDP forestry sector projects are implemented through the FAO Field Program.

The combined total funds (Regular Program plus Field Program) administered by FAO's Forestry Department for the 1982-83 biennium are $80.8 million out of total FAO funds of $1.05 billion. Regionally, the greatest allotment of funds is for Africa, $25.7 million, followed by Asia and the Pacific, $20.7 million. Latin America, with half of the world's remaining tropical moist forests, is budgeted for $13.4 million.

It is important to note that the Forestry Program is the smallest of FAO's three technical

programs—agriculture, fisheries, forestry—and indeed is dwarfed by the size of the agricultural component of FAO activities. As with other development institutions, the question remains whether FAO's support of large-scale projects that promote expanding agricultural production may be doing more to reduce tropical forest resources than smaller scale programs to conserve these resources can combat. Second, it may be asked whether a similar contradiction exists within the Forestry Department itself—whether, for example, FAO projects to develop forest industry and trade, such as the UNDP/FAO Pulp and Paper Industries Development Program, may be promoting unsustainable alteration of tropical forest ecosystems in some regions, while elsewhere other FAO programs are working to promote conservation.

Despite FAO's unequalled technical expertise, it is less effective than it might be in furthering policies and systems to sustain forest resources because of a relative lack, for want of a better term, of political effectiveness. The various development banks, particularly the World Bank, may have a more immediate and direct effect in promoting policies to sustain resources because of their very nature as financial institutions whose loans must be repaid.

Consultative Group on International Agricultural Research (CGIAR), Washington, D.C., U.S.A.

CGIAR is an informal association of governmental, regional, and international organizations and foundations whose task is to support and promote an international system of agricultural research centers and programs. The goal of these research centers and programs is to increase the quality and quantity of food production in the developing world. By developing and promoting more efficient crop strains and agricultural systems, CGIAR research could help to alleviate pressures to convert remaining tropical forests to other uses. However, some CGIAR research promotes existing land use patterns—e.g., the expansion of cattle pastures on acidic s ils of converted tropical moist forest areas. Such research may, at least indirectly, contribute to the destruction of tropical forest resources rather than to their conservation.

CGIAR was founded in 1971 under the joint sponsorship of the World Bank, UNDP, and FAO. The CGIAR Secretariat is located in Bank headquarters in Washington, and the CGIAR Technical Advisory Committee (TAC) is in FAO headquarters in Rome. TAC consists of 13 scientists who review the scientific and technical aspects of CGIAR programs and formulate suggestions for future activities. In 1980, CGIAR had 13 research centers and a budget of over $120 million.

The CGIAR supported centers are:

Centro Internacional de Agricultura Tropical (CIAT), Apartado Aereo 6713, Cali, Columbia

Centro Internacional de la Papa (CIP), Apartado 5969, Lima, Peru

Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), Londres 40, Mexico 6, D.F. Mexico

International Board for Plant Genetic Resources (IBPGR), Crop Ecology and Genetic Resources Unit, Food and Agriculture Organization of the United Nations, Via delle Terme de Caracalla, 00100 Rome, Italy

International Center for Agricultural Research in the Dry Areas (ICARDA), P.O. Box 114/5055, Beirut, Lebanon

International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Patancheru P.O., Andhra Pradesh 5022 324, India

International Food Policy Research Institute (IFPRI), 1776 Massachusetts Avenue, N.W., Washington, D.C. 20036, USA

International Institute of Tropical Agriculture (IITA), P.O. Box 5320, Ibadan, Nigeria

International Laboratory for Research on Animal Diseases (ILRAD), P.O. Box 30709, Nairobi, Kenya

International Livestock Centre for Africa (ILCA), P.O. Box 5689, Addis Ababa, Ethiopia

International Rice Research Institute (IIRI), P.O. Box 933, Manila, Philippines

International Service for National Agricultural Research (ISNAR), P.O. Box 93375, 2509 Aj, The Hague, The Netherlands

West Africa Rice Development Association (WARDA), E. J. Roye Memorial Building, P.O. Box 1019, Monrovia, Liberia.

Two of these institutions—CIAT and IITA—have programs of special relevance to tropical forest resources, since their focus is on improving agricultural systems in the humid tropics. CIAT studies the tropical areas of Latin America and the Caribbean with the goal of increasing food production on small farms and developing technology to promote agricultural production in underused areas with acidic, infertile soils. CIAT's research concentrates on four commodities: beans, cassava, rice, and beef in tropical pastures. CIAT has 90 internationally recruited agricultural scientists as staff and had a budget of $17.7 million in 1981. In addition, 250 participants are involved in research training internships at CIAT every year.

IITA has worldwide responsibility among CGIAR centers for the improvement of cowpea, yam, cocoyam, and sweet potato; it has regional responsibility (i.e., for lowland humid Africa) for research concerning cassava, rice, maize, soybean, lima been, winged bean, and pigeon pea. Of most direct relevance to sustaining tropical forest resources is IITA's Farming Systems Program, which is conducting research on traditional and new intercropping systems, including ones using fast-growing tree legumes.

United Nations University, Tokyo, Japan

The U.N. University was chartered in 1975 under the joint sponsorship of the U.N. and UNESCO. Its purpose is "to be an international community of scholars, engaged in research, post-graduate training and dissemination of knowledge in furthering of the purposes and principles of the Charter of the United Nations" (U.N. University Charter, art. I, sec. 1). Up to 1982, the university has had three principal programs: World Hunger, Human and Social Development, and Natural Resources.

The U.N. University Natural Resources Program has funded agroforestry activities at a rate of $200,000 a year, primarily in cooperation with CATIE in Costa Rica. The university has had a number of workshops, sponsored individuals in training courses at CATIE, and conducted research projects in northern Thailand, Costa Rica, Papua New Guinea, and the South Pacific. Other relevant activities within the Natural Resources Program include a Highland-Lowland Interactive Systems Project (with an agroforestry component), an Arid Lands Sub-Program, and a subprogram concerning energy systems for rural communities.

The U.N. University is being reorganized into three divisions: development studies (which will continue most of the tropical forest resource related work), regional and global studies, and global learning.

United Nations Environment Programme, Nairobi, Kenya

UNEP's role in the U.N. system is to serve as a catalyst and coordinating agency for environmental activities. This means that UNEP itself does not have the technical and professional capacity to undertake research or implementation projects concerning tropical forest resources. In conjunction with other institutions, such as FAO and UNESCO, UNEP has helped to initiate and support a number of tropical forest related projects.

Through the Global Environment Monitoring System, UNEP supported FAO in a comprehensive survey of tropical forest resources that established the first reliable estimates of the rate of conversion of tropical forests worldwide. UNEP cooperated with IUCN/WWF, UNESCO, and FAO in preparing the World Conservation Strategy, which articulated

definitive guidelines for reconciling development and conservation priorities.

Unfortunately, efforts by UNEP to initiate and promote international plans to deal with the problems of desertification and tropical deforestation have been unsuccessful. The U.N. Conference on Desertification in Nairobi produced a plan with 28 recommendations, but it has not been implemented, funded, or pursued. More recently, UNEP, FAO, and UNESCO jointly sponsored two meetings (Nairobi, 1980; Rome, 1982) to formulate a plan to combat tropical deforestation. A number of key tropical forest countries such as Brazil and Zaire refused to attend, objecting to international deliberations over what they regard as their domestic resources. The Rome meeting failed even to produce a plan, but rather issued a document that identified 30 elements of action and left concrete activities to the discretion of individual countries.

United Nations Educational, Scientific, and Cultural Organization (UNESCO), Paris, France

UNESCO sponsors activities that deal both with research concerning tropical forest resources and with protected natural areas (which can include tropical forest ecosystems).

The UNESCO Man and the Biosphere Program was established in 1971 and has the goal of using an international, interdisciplinary research program to find practical solutions to problems of natural resource and land development/management. MAB is divided into 13 projects, including over 1,000 field projects in more than 90 countries. These projects usually include research, demonstration, training, and educational activities. The total proposed UNESCO MAB budget for 1981 to 1983 is $22.5 million. Nearly one-fourth of this is earmarked for activities concerning humid tropical zones, and additional individual country contributions for specific projects in humid tropical areas total about $20 million.

MAB Project 1 is entitled "Ecological Effects of Increasing Human Activities on Tropical and Subtropical Forest Ecosystems" and includes about 40 field projects concerning tropical forest ecosystems. The projects are more or less equally divided among Latin America, Asia, and Africa. Typical MAB Project 1 projects include research pilot studies in Mexico on the feasibility of using pre-Columbian agricultural systems such as *chinampas* (raised fields in moist tropical forest areas) for increased food production and a series of baseline ecological studies on the effects of different land use patterns on the Tai rainforest in the Ivory Coast.

A number of other MAB projects have some relation to research on tropical forest resources:

1. Project 3, "Impact of Human Activities and Land Use Practices on Grazing Lands: Savanna, Grasslands (From Temperate to Arid Areas), Tundra;"
2. Project 4, "Impact of Human Activities on the Dynamics of Arid and Semiarid Zone Ecosystems With Particular Attention to the Effects of Irrigation;"
3. Project 6, "Impact of Human Activities on Mountain Ecosystems;"
4. Project 7, "Ecology and Rational Use of Island Ecosystems;"
5. Project 10, "Effects on Man and His Environment of Major Engineering Works;" and
6. Project 12, "Interactions Between Environmental Transformations and Genetic and Demographic Changes."

UNESCO has two programs to set aside natural protected areas, including tropical forests. The MAB Project 8, "Conservation of Natural Areas and of the Genetic Material They Contain," aims to establish a global network of representative samples of major ecosystems. The biosphere reserve concept embodies a core area that is left completely intact, surrounded by a semiprotected area where human modification of the ecosystem is allowed and can be studied. The UNESCO-administered World Heritage Convention aims to protect selected sites of outstanding cultural or natural value. The Convention also establishes a World Her-

itage Fund for the financing of some of the protected sites chosen by signatory nations.

Both MAB Project 8 and the World Heritage Convention are promising mechanisms for helping to establish protected tropical forest areas. Neither program is exclusively concerned with tropical forests, and they cannot, even if fully implemented, meet the need for a worldwide network of protected tropical forest ecosystems.

Total proposed funding for both programs for 1981-83, including contributions from the World Heritage Fund and UNEP, is slightly more than $2 million.

International Union of Forestry Research Organizations (IUFRO), Vienna, Austria

IUFRO is not a research or implementation agency; rather, it exists to promote international cooperation in forestry research, research techniques, and systems of measurement. It functions through correspondence, seminars, and, every 3 to 5 years, a World Congress where all aspects of forestry research are discussed. IUFRO has greatly expanded its membership in recent years from a nucleus of institutions based in Europe to a global network with, at the end of the 1970's, a membership of over 500 institutions and 10,000 scientists from 89 countries.

IUFRO is divided into more than 200 Scientific Research Units which are organized into six divisions—forest environment and silviculture; forest plants and forest protection; forest operations and techniques; planning, economic growth, and yield; management and policy; and forest products and general subjects.

International Society of Tropical Foresters (ISTF), Bethesda, Md., U.S.A.

After several years of inactivity, ISTF was reactivated in 1979 and now has over 1,000 members in more than 100 countries. Nearly two-thirds of the membership is outside the United States. The principal objective of ISTF is the transfer of information to improve the protection, management, and use of tropical forests. ISTF publishes a quarterly newsletter and plans to sponsor technical conferences, workshops, and training sessions on tropical forests. It is exploring ways to work with the International Council of Agricultural Research and the International Union of Forestry Research Organizations.

World Wildlife Fund-International (WWF), Gland, Switzerland

WWF is the world's largest nongovernmental conservation organization. In 1980, WWF spent nearly $10 million on 650 projects around the globe. WWF has 26 national affiliates in the developed world, and these affiliates, including WWF-US, spent $4.2 million on 382 nationally managed projects. WWF-International, through IUCN, managed 270 projects in 1980 whose cost totaled $5.39 million. Of this, about $2.5 million went to protecting endangered species, $0.5 million for protected areas, and the rest for educational programs, law, institutions, administration, development planning, protection of ecosystems, and area-based conservation projects. WWF/IUCN has been especially active in Indonesia, where they have completed a 5-year, $1.5 million program to promote the establishment of national parks and reserves.

For 1982-84, WWF is undertaking a $3 million fund raising campaign to support a proposed IUCN/WWF international conservation program for tropical forests and primates.

International Union for the Conservation of Nature and Natural Resources (IUNC), Gland, Switzerland

IUCN is an independent, international nongovernmental organization whose purpose is to promote scientifically based action directed towards the sustainable use and conservation of natural resources. IUCN has a permanent staff of about 20 professionals and does much of its work through a global network of over

1,500 scientists and other professionals organized on six IUCN commissions: ecology, education, environmental planning, species survival, national parks and protected areas, and environmental policy, law, and administration. IUCN helps to design and manage the projects of WWF, many of which are concerned with conserving tropical forest species and habitats.

More recently, IUCN has undertaken a number of special initiatives to help conserve tropical forest resources. IUCN was the lead institution in preparing the *World Conservation Strategy,* a joint UNEP/WWF/IUCN/FAO/UNESCO plan to promote sustainable development through conservation of natural resources. The IUCN Species Survival Commission has prepared a primate conservation plan, and IUCN's plans for 1982-84 include a major worldwide program to conserve tropical forests and primates. IUCN recently formed a Conservation for Development Center (CDC), which provides technical assistance to Third World countries and development assistance agencies to implement the environmental components of development projects. The biggest ongoing project of the CDC is a $250,000 *World Conservation Strategy* follow-up project to assist developing countries in preparing national conservation strategies.

IUCN has a membership of 54 governments, 114 government agencies, and 294 nongovernmental national and international organizations representing in total 110 nations. Unfortunately, IUCN's funding, dependent mainly on WWF and UNEP, was halved within 2 years (1979-81) and for 1981 was at a level of 5.9 million Swiss francs, or less than $3 million.

Lutheran World Service (LWS), Lutheran World Federation, Geneva, Switzerland

LWS works with a number of U.N. agencies and international voluntary organizations to provide assistance to the developing world. Its Community Development Service has disbursed over $90 million for more than 875 projects in about 50 countries since its founding in 1962. More than half of these projects have been in Africa, and they have focused on traditional community development priorities such as agricultural development, health care, and education. A number of these projects have had reforestation and community forestry components, especially in the Sahel region.

Lutheran World Relief (LWR) New York, N.Y., U.S.A.

Lutheran World Relief is the U.S.-based international Lutheran assistance service and is funded by the U.S. Lutheran churches. It is active in over 40 countries in the developing world and has disbursed over $10 million in assistance in 1981. LWR rarely operates its own programs—rather, it supports the projects of other public and private international organizations, including, of course, those of the Lutheran World Federation-Lutheran World Service. Of 25 recent LWR-supported programs, four deal principally with tropical forest resources: an agroforestry project, a fruit tree nursery project, a community gardening project in Niger, and a community reforestation project in India.

PRIVATE FUNDING FOUNDATIONS

Only a handful of U.S. foundations have substantial international programs. Support for all international and foreign-oriented projects amounts to only about 4 percent of the approximately $2.4 billion awarded each year by U.S. private foundations (24). Total support for tropical forest projects, though difficult to calculate, probably averages between $10 million and $12 million a year. Interest in tropical forest resources—as reflected in the popular press, conferences, and publications—is higher than in the past, so funding is probably as high as it has ever been.

This section describes 19 U.S. foundations

that have made significant grants in the past 3 years for projects related to technologies to sustain tropical forest resources (see table 3). It highlights numerous funding opportunities, including some that might be important for university programs and research.

The Ford Foundation, which accounts for nearly half of the total amount granted annually by U.S. foundations for tropical forest related projects, concentrates on community forestry. The Rockefeller Brothers Foundation spends about $600,000 a year on ecodevelopment projects, mainly in the Caribbean. The Andrew W. Mellon Foundation has averaged $400,000 a year in awards to U.S.-based institutions with strong tropical forest related research programs. In recent years, the MacArthur Foundation and the Richard King Mellon Foundation have each given one-time grants of $15 million to establish a World Resources Institute and to protect subtropical forests along U.S. southern rivers. Other foundations have granted smaller amounts, often because their limited mandates permit them only to fund projects for special purposes or for institutions in a limited geographical area. The oil company foundations such as Shell, Mobil, ARCO, and Exxon disburse over $30 million annually for general education purposes, but very little has been granted for projects relating to tropical forest resources.

Opportunities for funding correspond to the purposes foundations are emphasizing—for example, education and research, rural and community development, agricultural research, support of regional U.S. institutions, and some special purposes (e.g., chemical research) are areas of prime concern. The greatest unused opportunity for funding tropical forest projects appears to be the very important general education and university research support that oil company foundations provide. The widely differing purposes and procedures of different foundations inhibit effective and efficient funding of institutions and organizations seeking support.

Table 3.—Private U.S. Foundations Funding Tropical Forestry Research and Projects

1. Ford Foundation
2. Rockefeller Brothers Fund
3. Andrew W. Mellon Foundation
4. Richard King Mellon Foundation
5. Rockefeller Foundation
6. W. F. Kellogg Foundation
7. Tinker Foundation
8. John D. and Catherine T. MacArthur Foundation
9. Weyerhaeuser Foundation
10. Wallace Gerbode Foundation
11. Ahmanson Foundation
12. Camille and Henry Dreyfus Foundation, Inc.
13. Ford Motor Co. Fund
14. Mobil Foundation
15. Morgan Guaranty Trust Co. of New York
16. Shell Companies Foundation
17. Exxon Education Foundation
18. Atlantic Richfield Foundation
19. Inter-American Foundation

SOURCE: Office of Technology Assessment.

Selected Foundations

Ford Foundation

The Ford Foundation is the largest private funding agency supporting programs that directly or indirectly contribute to sustaining tropical forest resources. It is estimated that about 5 or 6 percent of Ford's annual program grants of approximately $90 million a year (1981) are somehow related to sustaining tropical forest resources (7).

The level of funding for such programs has generally remained constant over the past 4 or 5 years and was not substantially affected by the administrative reorganization of the foundation in 1980-81. Ford programs are divided into three main divisions: National Affairs, Education and Public Policy, and International. The International Division accounts for approximately 40 percent of Ford disbursements; within the International Division in 1981, nine Ford field offices in Asia, Africa, and Latin America spent more than $22 million.

The Ford Foundation focus is on projects and programs dealing with rural poverty and development. The field offices have considerable freedom to formulate their own programs within the general policies of the foundation. Perhaps as much as half of the amount disbursed by the field offices for rural develop-

ment touches natural resource management issues. The largest field offices are in India, Indonesia, and the Philippines, and are supporting innovative programs in community and social forestry and strengthening local governmental, academic, and nongovernmental institutions that deal with forest resources. An important part of Ford's support for social forestry programs is its commitment to help rural communities organize to more efficiently use existing institutional and governmental resources.

For example, in 1981 Ford awarded grants totaling over $400,000 to the University of the Philippines at Los Banos, De La Salle University (Philippines), and the Philippine Bureau of Forest Development for research, training, and community pilot projects to halt the destruction of upland forest areas. The foundation also gave substantial grants to a number of voluntary community organizations and universities in India to support village reforestation and fuel conservation efforts in the Himalayan foothills. A noteworthy element in Ford-supported community forestry projects is the importance placed on the role of women, who in many areas of the Third World have the central role in production and gathering of fuelwood and fodder.

Ford also is supporting key tropical forest resource research institutions in other parts of the world, such as ICRAF in Nairobi and the National Institute of Ecology and National Institute for Research on Biotic Resources in Mexico.

Rockefeller Brothers Fund, Inc.

The Rockefeller Brothers Fund is disbursing approximately $600,000 a year in grants for ecodevelopment as part of its international program. A substantial number of these grants are directly or indirectly related to sustaining tropical forest resources. It should be noted, however, that in recent years (1980-81) over $20.6 million of the fund's total annual grant awards of $25 million have been given to U.S. national and New York City projects.

The Rockefeller Brothers Fund stands out among major U.S. foundations by its strong support for the findings and implications of the *Global 2000 Report*—which identified tropical deforestation as perhaps the most serious and immediate ongoing global environmental problem. Since the mid-1970's, the fund has been a principal supporter of institutions in global environmental and resource research, such as the Worldwatch Institute and the International Federation of Institutions for Advance Study, and, more recently, the University of Michigan's School of Natural Resources.

The fund's support has focused heavily on the Caribbean region. In 1981, grants were approved for the Caribbean Conservation Association, FAO, VITA, and the Sierra Club Foundation. In some instances, sustaining forest resources is a component of a broader project to promote environmentally sound development. In other instances the fund has supported projects exclusively oriented towards sustaining forest resources, as is the case with its 1981 grant of $20,000 to the Sierra Club Foundation for its Caribbean mangrove management project.

Andrew W. Mellon Foundation

The Andrew W. Mellon Foundation distributes approximately $5.1 million of its total annual grants ($58 million) for proposals dealing with conservation and the environment. The foundation has no international program and thus only is able to fund the tropical forest-related activities of U.S. institutions. Tropical forest-related grants in 1981 included $320,000 to the World Wildlife Fund—U.S. for basic ecosystems research on the tropical forests of the Americas and $160,000 to the Yale School of Forestry and Environmental Studies toward a program of visiting professorships. In 1980, the foundation awarded $240,000 to the Organization of Tropical Studies at Duke University for support of training and research in environmental management, and $180,000 to the Washington, D.C.-based Worldwatch Institute in support of studies of population, conservation, and natural resource issues.

The foundation devotes nearly half of its annual support to higher education, but in recent years this aid has been exclusively focused on programs in the humanities.

Richard King Mellon Foundation

The Richard King Mellon Foundation awards a substantial portion of its approximately $25-million-a-year disbursements to national conservation organizations such as the Nature Conservancy and the World Wildlife Fund. Support is given for general purposes as well as for specific projects. In this sense, the foundation can be said to support technologies to sustain tropical forests by giving overall support to U.S. domestic conservation organizations that have international programs involved in tropical forest areas. In future years, the foundation's support of conservation activities at the international level could expand.

In 1980, the foundation gave a single grant of $15 million to the Nature Conservancy for the Rivers of the Deep South Conservation Project, a 10-year effort to protect the bottomland hardwood forests that form the corridors and watersheds for six important rivers.

The Rockefeller Foundation

The Rockefeller Foundation is most renowned for its support of the agricultural research institutions that originated and promoted the "Green Revolution"—the Consultative Group on International Agricultural Research (CGIAR) network. The Conquest of Hunger Program of the foundation continues to emphasize the importance of food production for sustainable development. One component of this program focuses on promoting the use of fragile environments and marginal lands in the tropics. Such support could be said to contribute to the stewardship of tropical forest resources by ensuring that the conversion of forest lands that does occur is sustainable. On the other hand, it can be argued that, in the social and economic context of many countries, such research to expand agricultural activity on fragile tropical forest soils can only contribute to the ongoing destruction of the remaining tropical woodlands.

Four of the five projects funded in 1981 in the "Utilization of Fragile Environments and Marginal Lands" subprogram concerned tropical forest resources. A $35,000 grant was given to the Centro Internacional de Agricultura Tropical in Colombia to prepare proposals on sustainable agricultural development in the Amazon; $100,000 to North Carolina State University for research on soil nutrient problems in the Amazon; $10,000 to the Instituto Nacional de Investigacion Agraria in Peru for the establishment of an Amazon agricultural research network; and $58,000 to the Rockefeller Foundation itself for research on opportunities for sustainable agricultural development in five major marginal land areas of the tropics.

Foundation funding is about $43 million a year, with $8 million annually going to the Conquest of Hunger program. Last year, about $220,000 of this went for marginal lands use projects.

Over the past few years the foundation has had an Education for Development Program that has funded social science and agricultural research and programs in universities in developing countries; this program is being phased out. An environmental quality program that supported U.S. domestic environmental organizations also has been discontinued.

W. K. Kellogg Foundation

The Kellogg Foundation is one of the three largest funding foundations in the United States, disbursing $53.2 million in grants in 1971. The foundation supports projects in the fields of agriculture, health, and education, and limits its geographic scope to the United States, Canada, Latin America, Australia, and a number of European countries. The foundation does not fund basic research and is not supporting any projects directly concerned with sustaining tropical forest resources. Indirectly, some of its agricultural projects in Latin America and the Caribbean may affect tropical forest resources. In 1981, agricultural projects in Latin America received $1.24 million.

The Tinker Foundation, Inc.

The Tinker Foundation was established to promote better understanding among the peoples of Latin America, Spain, and Portugal. Until 7 years ago, the foundation supported projects dealing exclusively with research in the social sciences, but since then has broadened its scope to include research dealing with natural resources and environment.

The Tinker Foundation disburses approximately $1.4 million to $1.8 million a year, of which about $300,000 goes for natural resource related programs. Of these programs, on the average only two grants a year deal with tropical forest resources, for an average funding level of around $30,000.

In 1978, the foundation awarded the second part of a 2-year grant to the Institute of Current World Affairs in New York City for its Forest and Man Fellowship Program. The foundation also gave a small grant to the Smithsonian Institution that year for a scientific conference on the processes of human adaption to the Amazon Basin. In 1981, 2 grants out of 45 dealt with tropical forest resources. The first was a grant of $7,500 to the International Society of Tropical Foresters to fund publication of a Spanish edition of the *ISTF Quarterly News,* which disseminates information on forestry research and technology transfer. The second grant was for $35,000 to Tulane University to establish a Mesoamerican Ecology Institute.

The Tinker Foundation also awards 6 to 10 postdoctoral fellowships per year. On the average, one fellowship has been awarded to a scholar working on a subject dealing directly or indirectly with forest resources.

John and Catherine T. MacArthur Foundation

With assets of nearly $1 billion and grant awards averaging $42 million a year, the MacArthur Foundation is one of the five most important in the country. In 1982, the foundation awarded $15 million to establish and support a World Resources Institute that will be located in Washington, D.C. The Institute will conduct policy research and analysis concerning global resource and environmental issues. The goal of the World Resources Institute will be to conduct studies to strengthen the capacity of governments, private corporations, and other institutions to understand and respond to the challenges posed by global environmental and resource problems. The foundation's support for the Institute is its first commitment to a project touching on tropical forest resource issues. In the future, the MacArthur Foundation plans to focus on domestic health, social, and political issues.

Weyerhaeuser Foundation

The Weyerhaeuser Foundation is a relatively small institution (current funding level is 12 grants a year totaling about $200,000) which in recent years has given significant support to projects concerned with tropical forest resources. In 1979, the foundation gave a 3-year, $50,000 grant to the World Wildlife Fund-U.S. for a study of the ecological basis for tropical forestry and reserve design in the Amazon basin. That same year Weyerhaeuser granted $20,000 to the African Wildlife Leadership Foundation in Washington, D.C., to initiate wildlife clubs in Tanzania.

The Weyerhaeuser Foundation is unusual for a small foundation in that it prefers to focus on proposals of national or international scope. It does not make grants to regional or local organizations in fields such as education, health, human services, and education. It does not fund university research or development.

The Wallace Gerbode Foundation

The Gerbode Foundation restricts its grants to projects having impacts on the San Francisco Bay area and Hawaii. The foundation favors research-oriented projects in the fields of environment, arts, education, and urban affairs. In 1980, the foundation awarded $18,000 to the Pacific Tropical Botanical Garden in Lawai, Kauai, Hawaii, to support the study and collection of medicinal plants in the Hawaiian

Islands . Total grants amount to about $500,000 annually.

The Ahmanson Foundation

The Ahmanson Foundation is one of the 25 largest foundations in the country and is disbursing some $7 million annually for broad purposes (education, health, humanities, social welfare), but exclusively to Southern California and Pacific Coast oriented organizations. In 1980, the foundations awarded a grant of $10,000 to the Pacific Tropical Botanical Garden in Hawaii.

The Camile and Henry Dreyfus Foundation, Inc.

The Dreyfus Foundation awards about $1.75 million in grants every year "to advance the science of chemistry, biochemistry, chemical engineering, and related sciences as a means of improving human relations and circumstances throughout the world." In 1980, the foundation gave $31,900 to the New York Botanical Garden for research in chemical aspects of plant-insect interactions and biochemical systematics of tropical plants.

Ford Motor Co. Fund

The Ford Motor Co. Fund distributes about $10 million in grants each year. Its primary focus is education, including research grants to universities and university-connected institutions, and secondarily social welfare, health, civic, and cultural programs. In 1980, it awarded $6,000 to the Missouri Botanical Garden for general support.

Mobil Foundation, Inc.

The Mobil Foundation disburses more than $8 million annually for general purposes; education (including research) receives over $3.5 million. In 1979, the foundation awarded $5,000 to the World Wildlife Fund-U.S.

Morgan Guaranty Trust Co. of New York Charitable Trust

The Morgan Guaranty Trust Co. of New York Charitable Trust awards nearly $2 million annually in grants. Although projects relating to health, welfare, and urban affairs have received more than half the amounts awarded in previous years, higher education, science, the environment, and international affairs are also areas that the foundation funds. In 1980, the trust gave an award of $5,000 to the World Wildlife Fund-U.S.

Shell Companies Foundation, Inc.

As of 1980, the Shell Companies Foundation awarded grants totaling nearly $5.7 million a year. About 33 percent of this was disbursed in direct grants to universities and colleges. Although no funds were given for university tropical forest related activities, such grants do not appear to be beyond the foundation's mandate. In 1979, the foundation gave a small support grant of $5,000 to the World Wildlife Fund-U.S.

Exxon Education Foundation

The Exxon Education Foundation is disbursing more than $15 million a year in grants to public and private colleges, universities, and professional education associations. Although the emphasis is on supporting interdisciplinary studies that address major social issues and on the economics and management of higher education, aid for tropical forest related research by universities is within the mandate of the foundation. In 1980-81, however, the only grant awarded that related to tropical forest resources was an award of $166,170 to Clark University for a seminar program for graduate students from lesser developed countries on the effective management of natural resources.

The Atlantic Richfield Foundation

The Atlantic Richfield Foundation (1981) is disbursing about $26 million a year, of which nearly $10 million goes for programs in higher education and environment. The only recent grant relating to tropical forest resources was an award of $100,000 to the International Institute for Environment and Development in Washington, D.C., in 1980.

Inter-American Foundation

The Inter-American Foundation is a public corporation created by the U.S. Congress in 1969 to pursue experimental alternatives in development assistance in Latin America and the Caribbean. In 1980, the foundation awarded grants totaling $23.2 million to nongovernmental peasant and community groups and services, cultural, and research organizations. About half of all project grants were for agriculture and rural development. Although no 1980 grants were specifically concerned with tropical forest resources, in 1982 the Foundation awarded $500,000 to the Fundacion Natura in Quito, Ecuador, to be disbursed to Indian communities in the Andean highlands for social forestry.

Foundations: Constraints and Opportunities

The problem of sustaining tropical forest resources—viewed in isolation from other concerns—is an issue of low priority for a handful of foundations and completely outside the agenda of the majority. Moreover, foundation concern for international issues such as tropical deforestation has been in a general decline for the past half decade. Only a few U.S. foundations have substantial international programs, and support for international activities of any kind amounts to only 3 to 4 percent of the $2.4 billion total disbursed by U.S. private foundations annually (23,24). Total U.S. foundation support for projects relating to tropical forest resources is estimated to average $10 million or $12 million a year, about half awarded by the Ford Foundation.

The early and mid-1970's were a time of heightened domestic environmental concern, and major foundations such as Ford and Rockefeller established environmental programs. In some instances these supported U.S. environmental organizations that were engaged in international activities relating to tropical forest resources. At Ford and Rockefeller, such funding has been phased out. One foundation that is continuing to support international tropical forest resource related activities of U.S. environmental groups is the Andrew W. Mellon Foundation.

However, U.S. foundations are continuing to support tropical forest related projects that have been designed to correspond to the categories of projects that the foundations do emphasize: education and research, rural and community development in the Third World, agricultural research and experimentation to deal with world hunger, support of U.S. regional institutions, and special purposes (e.g., support of chemical research).

Although a superficial survey of foundation support for tropical forest related activities and research is discouraging, there are considerable opportunities for increasing support by presenting programs and projects in the context of the current priorities of a number of foundations.

For example, the Ford Foundation is spending at least $5 million of its $90 million yearly disbursements on village and social forestry related projects and related research in the developing world. Although the stated policy of Ford is to promote projects addressing rural poverty in the developing world, sustaining tropical forest resources through social forestry pilot projects and research is a key element of its strategy (10). Ford is also playing an innovative—and regrettably almost unique—role in promoting the role of NGOs and women's groups in relation to its community forestry activities. The Inter-American Foundation—which is a U.S. Government-supported and not a private institution—is the only other U.S.-based foundation that has a mandate or policy to give substantial support to private voluntary organizations and other NGOs in the Third World.

Opportunities for increased support can be found in foundations whose mandates might at first seem to be far removed from the topic of tropical forest resources. These include foundations that only support programs or institutions in a particular U.S. region or city. The Gerbode and Ahmanson Foundations, for example, have mandates limited to Hawaii and to the San Francisco and Los Angeles areas,

respectively. Yet, both recently gave support grants for tropical forest related research to the Pacific Tropical Botanical Gardens in Hawaii. As another example, the Dreyfus Foundation has a mandate to advance the science of chemistry and chemical engineering, and in 1980 the foundation granted over $30,000 to the New York Botanical Garden for research concerning the chemical aspects of plant-insect interactions in tropical forests.

The greatest opportunities for increased support lie in the field of university education and research. This is the most heavily supported grant area for many U.S. foundations. It is important to remember, however, that some foundations are narrowly focused in their support for higher education. For example, although the Andrew Mellon Foundation supports tropical forest related work of domestic environmental groups (including university-affiliated institutions such as the Organization for Tropical Studies), the nearly $25 million it disburses annually for higher education is used to support the humanities and liberal arts (1). On the other hand, a number of substantially endowed foundations—particularly the oil company foundations such as Mobil, Atlantic Richfield, and Exxon—have mandated commitments to general support of higher education and research. These foundations have supported relatively little tropical forest related work. But this is not because of an aversion to international natural resource and environmental issues, as recent small grants to the World Wildlife Fund-U.S. indicate. U.S. botanical gardens, university consortia, and other research institutions with programs related to tropical forest resources might do well—given the increasingly apparent constraints to Federal support—to explore these foundations with more persistence.

Some of the constraints to U.S. private foundation support of tropical forest resource related programs have already been mentioned—i.e., diminishing concern in most foundations, and in American public policy as a whole, for international and environmental problems. The orientation of many leading foundations has become more concentrated in the past 3 or 4 years on domestic economic and social concerns, and their international programs have focused on analogous issues concerning rural development and food supply in the Third World.

This has not caused a substantial decline in support for tropical forest resource related projects, as that issue has only become a subject of more widespread international and domestic concern within the past 4 years. The shift in priorities of major foundations does mean that institutions and programs seeking support must be more creative in researching existing opportunities for support.

The bewilderingly different policies and procedures among the foundations that support tropical resource related programs present a formidable obstacle to individuals and organizations seeking support. Thus, it would be useful to have a centralized information system to match prospective donors and proposals. An important step towards estalishing such a system occurred in 1981 with the founding of Grantmaking International (77 United Nations Plaza, 5th Floor, New York, N.Y. 10017). Grantmaking International is a mechanism for exchange of information and grant proposals among grantmakers who wish to improve and coordinate their funding efforts in the international field (23,24).

Another prime constraint on effective channelling of private foundation funds into projects to sustain tropical forest resources comes from the lack of consensus domestically and worldwide on the best strategy for dealing with natural resources threatened by population and economic pressures. The *World Conservation Strategy,* prepared by the International Union for the Conservation of Native and Natural Resources with the aid of the U.N. Environmental Programme and the World Wildlife Fund, is one attempt to alleviate this constraint and might be a useful guide at both the national and international levels.

Chapter 3

Private Sector Involvement

Contents

	Page
The Role of the Private Sector	49
The Effects of Size on Private Sector Involvement in the Tropics	51
Conclusion	51

Table

Table No.	*Page*
4. U.S. Forestry Firms in Tropical Countries	49

Chapter 3

Private Sector Involvement

THE ROLE OF THE PRIVATE SECTOR

Historically, perhaps the greatest involvement of U.S. interests in tropical forests has been in the private sector. U.S-based companies have been involved in forestry operations in tropical areas at least since the early 1900's. The value of tropical hardwoods (logs, lumber, plywood, and veneer) imported into the United States totaled $537 million in 1978. By the year 2000, U.S. demand for tropical hardwood sawtimber is expected to increase 75 percent. Because of the longer growing seasons and faster growth rates possible in tropical forests, the U.S. paper industry is expected to begin using wood from the tropics for its processes as well.

Other forest products have drawn an increasing variety of private businesses to opportunities in tropical forests. For example, as many as one-half of all U.S. prescriptions contain ingredients of natural origin, and they are valued at over $3 billion (16).

The extent of the private sector's role in the research, development, and implementation of technologies to sustain tropical forest resources (i.e., the search for ways to keep the forests economically and environmentally stable in future years) is not clear. Involvement has varied from company to company because each firm has its own perceptions of needs and opportunities and of the current and future economic outlook. Only a few U.S. firms specializing in exploitation of primary resources (e.g., timber or minerals) have contributed directly or substantially to developing technologies for the tropics. The more important role such firms play is transferring technologies to local institutions, which then adapt them to tropical situations.

The private sector certainly has skills and knowledge important for forestry activities in tropical countries. The expertise varies according to the type of business, its size, and the corporate philosophy. Generally, the opportunities for information transfer fall into two categories: technical skills and business skills.

U.S.-based multinational forestry corporations traditionally have had the most to offer and the most to gain in ensuring that tropical forest resources are maintained. These companies are a great storehouse of information and experience in forest management or, more specifically, in converting natural forests into managed forests. Although much of that knowledge and experience was acquired in temperate climates, the technical know-how for nursery and seed orchard establishment; the methods to establish tree improvement, pest control, fertilization, and other silviculture programs; and the capability to adapt various harvesting, transportation, and processing equipment to local sites can be transferred. Companies also can contribute by sharing organizational and managerial skills.

Although U.S. forestry companies with overseas concessions have in the past concentrated on manufacturing and marketing tropical forest products, in light of dwindling supplies they have started applying their expertise to managing the forests within their concessions. About 23 U.S.-based forestry firms (see table 4) have

Table 4.—U.S. Forestry Firms in Tropical Countries (1981)

1. Balsa Ecuador	12. John Miles Co.
2. Boise Cascade	13. Kimberly Clark
3. Champion International	14. Olinkraft
4. Container Corporation of America	15. Pascagoula Veneer
5. Continental Forest Products	16. Resources International
6. Crown Zellerbach	17. Robinson Lumber
7. Ford International	18. Scott Paper
8. Georgia-Pacific	19. Sonoco Products
9. Gould Paper	20. St. Regis
10. International Balsa	21. U.S. Plywood/Champion
11. International Paper	22. West Virginia Paper Co.
	23. Weyerhaeuser

SOURCE: J. S. Bethel, et al., "The Role of U.S. Multinational Corporations in Commercial Forestry Operations in the Tropics," a report submitted to the Department of State, University of Washington, 1982, 306 pp.

operations in the tropics. Some of these firms are pulp and paper facilities that buy pulp and convert it into end products; some use nonforest resources (e.g., bagasse or waste paper) for pulp and paper facilities; some have simply set up offices to explore the feasibility of establishing operations in the host country; some are conducting joint research studies; less than half actually have active forest concessions (3). In the future, it is likely that there will be continued transfer of industrial development projects (e.g., large sawmills, plywood plants), as well as U.S. involvement in the management of large-scale forest plantations and natural forests. Given the size, scope, and orientation of profitmaking companies, the potential contribution that the U.S. forest industry can make to tropical forestry is more relevant to the needs of regional or national development than to the needs of local populations.

Other kinds of private industries could also make important contributions to the research, development, and implementation of technologies to sustain tropical forest resources. For example, pharmaceutical companies might be involved because chemical compounds extracted from tropical forest plants have been used directly as drugs, starting materials for the synthesis of drugs, or models for drug synthesis (2). In fact, approximately 25 percent of all the prescriptions written in the United States contain at least one product from a plant and the market for natural-plant-derived drugs is estimated to be $8.1 billion (1980 estimate) a year in the United States (9). Yet, only about 10 percent of the roughly 250,000 kinds of plants have ever been examined to see if they contain any product of potential commercial value (18).

In the past, some pharmaceutical firms had "natural products programs" to conduct systematic studies of exotic flora for compounds of pharmacological interest (12). Other firms viewed this sort of plant screening as unproductive, with results less than proportional to the effort involved. Few companies now conduct research on higher plants as a source of new drugs and the National Cancer Institute recently ended its screening program. There are many reasons for this decline in interest in botanicals. First, the research investments often do not pay off because it is difficult to patent a natural compound extracted from a plant (though it is less difficult to patent an extraction process). Further, natural substances have trouble meeting the specifications of the Food and Drug Administration. Because the process for introducing a new drug can take 6 or 7 years, companies are increasingly unwilling to make such investments. Despite these constraints, U.S. pharmaceutical companies do possess the technical knowledge and the financial capital to invest in plant screening programs, either through direct financing or through collaboration with pharmaceutical industries in developing countries.

Agribusiness is another industry that contributes to sustaining tropical forest resources. Its role would be similar to that of the forest product industry: help research and develop sustainable agriculture technology systems, train local people, establish nurseries and orchards for planting materials, produce mycorrhiza, apply tissue culture techniques, etc. The possible effects include: more cash flow, more production per unit of land, and less pressure on forest lands.

U.S.-based agribusinesses also are conducting research that could have indirect applicability in the tropics. For instance, one company is conducting a feasibility study of growing wood for biomass to produce electricity to power its mills. If successful, fast-growing biomass energy plantations could be established elsewhere, especially where fuelwood is in high demand and the cost of oil is prohibitively high.

THE EFFECTS OF SIZE ON PRIVATE SECTOR INVOLVEMENT IN THE TROPICS

The private sector can be further divided into large and small businesses, each structure having its own strengths and weaknesses. As indicated in the previous section, large businesses have the capital, labor, and skills to devote to the research, development, and implementation of technologies to sustain tropical forest resources. However, their size and complex organizational structure tend to make large businesses cautious, conservative, and inflexible (4). Small businesses, on the other hand, have certain advantages that might be capitalized upon in the quest for improved use of tropical forest resources. Foremost among these is innovation.

Throughout history, independent entrepreneurs and small enterprises in the United States have been frequent purveyors of innovation. Two-thirds of patented major inventions in the last 50 years were discovered by individuals or small businesses (15). This occurs in part because the independent entrepreneur has more freedom to create and pursue new ideas or products. Small enterprises are usually more adaptable to change. Decisionmaking is often confined to one or two persons. They also tend to have closer communication with their customers, thus enabling them to meet special customer needs. For a small business, a single new product can play a significant role and thus can receive a large commitment of energy and funds. That same product might be insignificant in relation to a large corporation's sales or services. Small firms are often product-research-oriented and opportunistic in research and development. They often "fill the gaps" that big companies leave out and consider too risky, not proven, and too future-oriented. These advantages could be important in developing technologies to sustain tropical forest resources.

Biotechnology firms, for example, already are pioneering the use of vegetative propagation and tissue culture techniques for a number of tropical food and tree crops. Because markets are small, it is small businesses that are supplying seeds and seedlings to tropical countries for plantation projects. Further, a great deal of information is transferred by individuals and small firms acting as consultants in a variety of activities: they conduct feasibility studies, build nurseries, establish research facilities, and supply expertise on many topics.

The role of small enterprises is highly individualized. Each company has different personnel, expertise, and goals and thus has different effects. Often, a small firm will reflect the personality of its creator quite strongly. There also are disadvantages in small businesses that must be considered (e.g., such firms may have less investment capital or their staff may lack management skills). Overall, however, it seems that there might be special potential for the involvement of small enterprises in developing and implementing technologies for sustaining tropical forest resources.

CONCLUSION

The private sector has much to offer to the research, development, and implementation of technologies to sustain tropical forest resources. This sector can help stimulate the less developed countries growth and, in the process, it can benefit from more reliable sources of goods and new investment opportunities. A number of businesses are interested in increasing private sector exchange programs which include: on-the-job instruction in the United States, consulting, onsite workshops and training programs, support of local scientific and educa-

tional institutions, serving as guest speakers at foreign universities or management institutes, and sponsoring attendance of developing country personnel at international symposia and conferences (13). The private sector's major contributions are investment in research and development of technologies, transfer of existing technologies and their adaptation to local conditions, and training of managers and technicians.

Chapter 4

Constraints and Opportunities

Contents

	Page
Institutional Roles, Involvement, and Coordination	55
Constraints	56
Lack of Communication	56
Lack of Funds	56
Lack of Adequate Technologies	56
Lack of Knowledge	56
Political, Cultural, and Institutional Constraints	57
Contradictory Efforts	57
Opportunities	58
Strengthening Existing Institutions	58
"Twinning"	59
Establishing a Small, Central Coordinating Institution	60
Increasing the Role of the Private Sector and Private Voluntary Organizations	60
Summary	61

Chapter 4

Constraints and Opportunities

INSTITUTIONAL ROLES, INVOLVEMENT, AND COORDINATION

U.S. and international institutions play a variety of roles in developing and implementing technologies to sustain tropical forests. The nature of each institution's activities, and their effectiveness, is highly variable. The U.S. institution with the largest impact, and the greatest opportunity for future impacts, is the Agency for International Development (AID). This agency has a strong legislative mandate directing it to act to sustain tropical forest resources in support of basic human needs. Internationally, the World Bank, the Food and Agriculture Organization (FAO), World Wildlife Fund, and certain other institutions have been increasing their involvement in forestry-related activities.

It is important not to be misled by the apparently large number of institutions listed in this document. Even though OTA located more than 50 institutions involved in tropical forestry work, in few of these was reforestation, forest maintenance, or conservation a high priority. These institutions devote far more staff, funds, and other assistance to other types of development activity than to forestry. Furthermore, international funding for forestry activities is dominated by industrial projects. Analyzing the effects of that dominance, a recent U.S. Forest Service report states:

> Industrial assistance projects cover heavily capitalized pulpmills or sawmill complexes, rather than on-the-ground establishment and management of forest stands. Continuation of this trend would exert greater pressure on existing forest reserves and contribute to the deforestation problem (25).

The Forest Service also points out that few donors are involved in forest conservation activities, probably because conservation projects often do not seem economically viable. Some other relevant conclusions from that study are:

- A number of donor projects are contributing to deforestation or will fail in reducing the problem because inadequate attention is paid to ecological effects. Road building, agriculture, hydroelectric, colonization, and industrial forest harvest projects are potential causes of deforestation.
- Donor agencies operating in the same country tend not to communicate with each other. This leads to duplication of efforts or failure to learn from the mistakes and successes of others.
- Forestry projects are often imposed on local residents rather than being based on what the community wants and needs. As a consequence, many donor projects fail because of "lack of cooperation" from local residents.
- Donor organizations often exhibit little acceptance or understanding of the value systems, cultures, and traditions of the recipient countries in the design and implementation of forestry projects.
- It is possible to create a negative impact by flooding a country with excessive donor activities or funds. Donor organizations may implement oversized projects in countries not yet ready to absorb them into their existing political and economic structure. Often, when project funding has ended, the country is ill-equipped to carry on because of bottlenecks in education, managerial talents, and other factors.
- Projects are often started but left unfinished, or not properly followed up, because of inadequate funding beyond initial budget commitments. Also, donors often fail to recognize the long-term nature of forestry activities in their budget allocations (25).

CONSTRAINTS

Lack of Communication

One constraint emphasized in the Forest Service report is inadequate communication. Projects suffer when researchers or field staff do not communicate with each other, when planners do not communicate with recipients, and when donor agencies do not communicate with other agencies. The widespread lack of communication and coordination greatly reduces the effectiveness of existing programs, but improving communications is more difficult, and more expensive, than might be expected. Distribution of timely information, especially when the most important audience is in developing countries, can face many obstacles, both logistical (getting information to appropriate recipients) and human (finding the right readers and getting them to read and use the information).

Encouraging donor agencies to communicate and coordinate with each other should be a less formidable task, but in reality it is not. First, there are a great number of national, international, regional, and local institutions to follow. Many agencies simply do not have the capacity to do this. Communicating with other agencies is often seen as an inappropriate infringement on staff time simply because interagency coordination is seldom an explicit objective in agency policies. In some cases, donor institutions compete with each other for influence and thus avoid communication for what is an unhealthy and counterproductive rationale. More often, there are simply too many other things for an institution to accomplish with limited staff and funds. Finally, there is the additional problem of language—often the technical literature is in English rather than languages more useful to the recipients.

Communication between donor institutions and recipients (both at a country and local level) was once a sorely neglected aspect of project planning and implementation. Recently, however, the cultural and social elements of projects have been receiving much greater attention.

Lack of Funds

Constraints on attempts to sustain tropical forest resources can occur at various levels: within the aiding institutions (whether United States, international, or regional), within the recipient countries, and within the local recipient communities. One constraint often cited at all levels is lack of funds. More money, it is so often argued, will bring more results. It is heard from the field, from project designers, and from the institutions themselves when soliciting support from their governments or contributors. The problem is, of course, that the current economic climate makes it exceedingly difficult to obtain increased funds or new funds. Many legitimate development issues need financial support and thus compete for a limited resource—money. Thus, while additional financial support will be needed to develop forest resources on a sustainable basis, institutions need to search for more innovative and effective ways to use the existing funds.

Lack of Adequate Technologies

Many experts believe that the major constraints on sustained use of tropical forests are institutional, social, and political, not technical. Some techniques that can be used to reforest degraded lands, for example, are relatively well known (see the OTA Background Paper *Sustaining Tropical Forest Resources: Reforestation of Degraded Lands).* Why, then, are these techniques not widely in use? One reason is that although they are technically feasible, they often are not economically attractive enough to compete successfully against the forest-degrading practices. Thus, there is a strong need to develop technologies that are both scientifically and socioeconomically sound.

Lack of Knowledge

Tropical ecosystems are extremely complex. Further, forest resource problems—and their solutions—are very site-specific. There is a vast amount of knowledge yet to gain about the

functions and potential products supplied by natural forests. Because research often is site-specific, the knowledge gained is not always transferable. Better baseline research is needed to develop a sustainable, scientifically sound resource-use system for many of the endangered tropical forest regions. Site-specific research is necessary both to understand the resources and the needs of the local populations. Unfortunately, such knowledge cannot be gained quickly.

Political, Cultural, and Institutional Constraints

The key factors constraining many forest management efforts are social, not scientific. What is often lacking is the political commitment to allocate more staff and funds to:

- conduct the necessary, long-term baseline ecological and sociological research;
- provide ecologically sound support for local populations during the lag between investments in trees and realization of the benefits; and
- provide necessary, long-term monitoring of projects so that they can be improved as needed.

Working on one front alone is not enough. The United States cannot have great influence on the internal politics of natural resource use in the tropical countries, or on the cultural constraints, but it can work to improve institutional capabilities.

Institutional constraints vary greatly depending on the institution and its purposes. Regional and international research institutions often have difficulty being site-specific and staying attuned to local ecological, anthropological, economic, and political conditions. This can inhibit efforts to develop technologies, especially if there is a lack of local institutions to adapt the technologies to local conditions. In some cases, capable local institutions do exist, but are under political constraints that limit communication with the international institutions. Innovative national institutions that have successfully adapted and implemented technologies include INIREB, EMBRAPA, and INPA. These might be suitable subjects for in-depth case studies to determine whether their success could serve as a model for developing similar institutions elsewhere.

One important political constraint is the attitude toward tropical forest resources. Often, forestry concessions are viewed just as revenue-raising devices rather than also as forest management tools. Legislation is needed to promote integration of forestry and land use planning within the affected countries, but only a gradual education process can assure government backing for such policies.

Contradictory Efforts

There is a general lack of consensus and unified policy on how to reconcile economic development of tropical forest resources with the need to preserve genetic diversity and other nonindustrial forest functions. This sometimes leads to institutions working at cross purposes. At times the contradictory efforts are accidental; one donor agency simply did not know what other agencies were doing. Other times they seem truly schizophrenic—one hand of an institution financing a reforestation project while the other finances projects to convert primary forest into agricultural land.

Sometimes such apparent conflicts are the inevitable result of different institutions having different, though equally legitimate, goals. For instance, the Consultative Group on International Agricultural Research (CGIAR) institutions strive to increase and promote agricultural production and expansion. The expansion often occurs at the expense of forests and in conflict with institutions that are working to prohibit agricultural clearing on forest lands that cannot sustain it. In times when development funds were more plentiful, coordination of effort may have been less important. But today coordination is essential to assure efficient use of existing staff and funds.

OPPORTUNITIES

The constraints listed in the previous section are not insurmountable. There have been encouraging signs in the past few years that some of the leading multinationals such as World Bank and FAO have begun to shift their forest development priorities from nearly total emphasis on industrial forestry to more work on community forestry, agroforestry, and institutional building. While there is criticism that implementation of these new priorities has lagged (25), the shift in policy is an important beginning.

Strategies to improve the capabilities of institutions to develop and implement technologies to sustain tropical forest resources include:

- strengthen existing institutions,
- pair existing national institutions in developing tropical nations with institutions in developed nations that can provide technical support (twinning),
- establish a small coordinating secretariat (a CGIAR-like institution) to focus on tropical forest resources, and
- increase the role of the private sector and private voluntary organizations.

Strengthening Existing Institutions

Given the vast array of institutions listed in this study alone, it is clear that substantial institutional capacity exists to deal with the problems of deforestation, forest use, and maintenance. Thus, one way to enhance tropical forestry efforts is to determine which of these institutions are most capable and to strengthen them. This could increase effectiveness, reduce duplication, and concentrate available staff and funds. This strategy could capitalize on the great diversity among existing institutions.

In the United States, a number of opportunities exist to strengthen existing programs, projects, and agencies. Foremost among these would be to support and encourage forestry efforts of AID. AID has a clear mandate from Congress to develop and strengthen "the capacity of less developed countries to protect and manage their environment and natural resources" (Section 118 of the Foreign Assistance Act) with explicit authorization for assistance to "maintain and increase forest resources" (sec. 103b). In 1981, section 118 was further amended to express congressional concern "about the continuing and accelerating alteration, destruction, and loss of tropical forests in developing countries."

One step in strengthening AID, then, would be to see this policy mandate translated more often into action. This could be done in a number of ways, beginning with educating AID personnel to the importance of these forestry concerns. More AID projects and programs could include environmental components to enhance their impacts on tropical forest resources. More project designs could allocate a percentage of funds to relevant environmental protection measures—for instance, hydroelectric development could include components to maintain forest cover on the surrounding watersheds. Because many development activities AID conducts have direct and indirect impacts on tropical forests, to consider reforestation and similar actions only on those projects specifically aimed at forest conservation is missing opportunities to have a much wider impact.

Another way AID could enhance its effectiveness in this sphere is through its administration of the Public Law 480 Food for Peace program. AID administers some $1.6 billion per year in Food for Peace activities, but at present, only about 1 percent of the Public Law 480 projects are concerned with sustaining tropical forest resources. More of these funds could be directed to planting trees and assuring local involvement. Public Law 480 foreign currency reserves could also be used to fund forest research, perhaps including a greater involvement by the U.S. Forest Service.

This redirection of existing efforts is one way to increase U.S. involvement without adding

new financing. Similarly, the international components of other U.S. Government agencies and programs could be expanded to play a more active role in sustaining forest resources. Both the U.S. Fish and Wildlife Service and the National Park Service, for instance, have much relevant expertise and could be encouraged to expand their international involvement. Both agencies could do more to foster international coordination and dissemination of research and management technologies related to wildland tropical forest resources.

The international importance of the U.S. National Science Foundation (NSF) and the National Academy of Sciences (NAS) should not be underestimated. Research sponsored by or financed by these two agencies has significant direct and indirect impacts on sustaining tropical forest resources. These two agencies should continue to be seen as key components of science research and should be rewarded and encouraged for their work on important international environment issues.

Another opportunity to strengthen existing institutional structures concerns the UNESCO Man and the Biosphere (MAB) program. MAB has supported some 1,000 field projects in 90 countries. Nearly one-fourth of its $2 million 1981-83 budget is for activities related to humid tropical zones, and MAB has a commendable record of supporting innovative research on tropical forest resources. It has a good international reputation and has been successful in supporting small-scale and pilot project research. UNESCO is the organizing agency for MAB, but each country's effort is funded independently. The U.S. contribution now comes almost entirely from the Forest Service.

There has been much debate on which of the existing institutions ought to take the "lead" in tropical forest resources work. The discussions revolve around which institution is most effective and whether it might be encouraged to become the center and coordinator for all tropical forestry programs. Two institutions sometimes mentioned for this role are FAO and the International Union of Forestry Research Organizations (IUFRO).

FAO has a great wealth of tropical forestry expertise and experience. Its Forestry Department employs about 300 people working in 70 countries and had a regular program budget of $14.7 million in 1982-83. It is actively involved in field programs and technology transfer. It is important to note that the FAO forestry program is dwarfed by the size of FAO's agricultural component. It may be that an organization with such a strong commitment in one field could not make the necessary adjustments in internal priorities to lead effectively in the area of forestry as well. In fact, one frequently cited criticism of FAO is that it is a huge, slow-moving bureaucracy in which forestry is not a significant issue (20,21). FAO is considered effective in some of its technology transfer efforts, but lacks the political influence of other institutions such as World Bank or AID. FAO is also sometimes limited by its own policy of responding only to in-country requests. It cannot initiate projects of its own.

IUFRO, on the other hand, is specifically committed to forestry, but it is a smaller, less active, and less visible organization. IUFRO promotes international cooperation in forestry research and in recent years has expanded its membership to some 600 institutions and 10,000 scientists from 89 countries. Its current functions, however, are research oriented and would need to be expanded to include implementation. Further, IUFRO operates on a minimal budget that would need to be expanded if its responsibilities change. Both FAO and IUFRO could play increasingly important roles but neither organization alone seems suitable to be the leading coordinator of international efforts in tropical forestry work.

"Twinning"

In September 1981, at the meeting of the IUFRO members held in Kyoto, Japan, a joint World Bank/FAO paper was presented ("Forestry Research Needs in Developing Countries—Time for Reappraisal") that outlined an innovative arrangement to improve capabilities for conducting research and technology transfer in developing countries called "twinning."

During discussions at the IUFRO meeting and afterwards, many leading donor agencies debated priorities for continued research and technology implementation and the strengths and weaknesses of various international and national institutions. The general consensus that emerged was that:

- There is a need to shift the emphasis of forestry research in developing countries toward new areas of concern such as agroforestry, biomass, and tropical forest ecosystem conservation.
- In building up research capability, the first priority should be given to strengthening national institutions within the developing countries themselves.
- Both IUFRO and FAO should take steps to strengthen their capability for technical support of research in developing countries.
- More effective use should be made of the research capability that already exists in many research centers identified in the World Bank/FAO report (11,27).

One way to accomplish these goals is a "twinning" arrangement, in which a developing country research institution is paired in a long-term, mutually supportive arrangement with a specific external institution that has relevant expertise. The developing country institutions have the best ability to understand social, economic, and political factors, while the external institutions have needed research capabilities and technical expertise (27).

Twinning arrangements allow more and continued contact between the staffs of the paired institutions. They also encourage institutions to use existing resources. For instance, the combination of forestry and agriculture is a relatively new field of research. At the national level in the developing countries, however, there already exist more than 1,000 agricultural research institutes or agencies. Thus, when ICRAF sought to do agroforestry research in Kenya, they chose as the site an existing agricultural research station. The station had been studying appropriate farming systems for semiarid lands for many years and had extensive contacts and experience in the area. By grafting the forestry work onto a well-established program, there are increased opportunities for rapid transfer of the agroforestry research to the level of the small-farm operator (27).

Establishing a Small, Central Coordinating Institution

Lack of communication and coordination is a major constraint to the development and implementation of technologies to sustain tropical forest resources. Various donor agencies have commented that developing countries' programs could be more effectively supported by creating a small International Tropical Forestry Secretariat. Its main functions would be keeping scientists in developing countries informed of other projects and research, promoting new research, helping organize conferences, and ensuring that research agencies in developing countries are aware of appropriate publications and information (27). The secretariat could also be used to coordinated twinning arrangements.

Such a forestry secretariat could be patterned after CGIAR. CGIAR is an informal association of 44 country-members. It supports 13 agricultural research institutions located in developing countries and serves to foster communication and coordination. If a forestry secretariat is formed, it could consist of a small core staff and need not be involved in implementing its own research projects. As in the CGIAR structure, various forestry institutions could develop specializations to avoid duplication (e.g., one institution could focus on nitrogen-fixing trees, another on *Eucalyptus,* etc.). The secretariat might be established within the existing IUFRO or FAO structure. A major interagency problem would remain, however, as such a small, international body could do little to coordinate efforts within nations.

Increasing the Role of the Private Sector and Private Voluntary Organizations

The private sector can be an effective technology transfer agent and could play an important part in efforts to develop and implement

technologies to sustain tropical forest resources. Of course, the types of research and development that interest commercial firms are usually limited because they are looking for potential profits.

Private voluntary organizations (PVOs), on the other hand, operate from a different philosophy and thus offer different potential benefits. They, like private businesses, are generally able to act with more speed than can the public sector. But since profits are not an issue, they can have a wider range of involvement. PVOs are especially successful in small- and pilot-scale projects and should be encouraged to continue such work. The World Wildlife Fund, for example, is well known for its efforts to conserve wildlife and habitats and has been increasingly effective in some of its projects (20). Considering the success of some grassroots environmental movements (for example, India's "Chipko," or "hug a tree" movement), there are also opportunities to strengthen PVOs in the developing countries.

SUMMARY

There are as many as 600 forestry research institutions in the world, with at least 90 conducting significant programs related to tropical forests. The number of implementation-oriented institutions, funding foundations, private voluntary organizations, and private firms involved in tropical forestry is also large. While it is difficult to generalize about the roles these institutions play in sustaining tropical forest resources because they vary with the objectives of each institution, it is clear that existing institutional structures provide ample opportunity for efforts to sustain tropical forest resources.

The great number of groups involved, and the diversity of their goals, can be both an asset and a constraint. The diversity can be an asset because it allows the problems of tropical forests to be combated with multiple strategies. It can be a constraint, however, because it causes problems and inefficiencies. Often, for instance, different institutions work at cross purposes, with or without knowledge of the overlap. Other times, there is unnecessary duplication of efforts or competition between organizations. Often, there is simply a lack of communication between the various groups. Improved coordination and communication are essential if efforts to sustain the tropical forests are to be successful.

Actions to sustain tropical forest resources must be seen in the context of overall development—as part of a comprehensive program to both immediate and future human needs. The key institutional factors for successful implementation of existing technologies include: coordination among donor agencies within specific countries; development of mechanisms to ensure local participation in planning and implementation, including economic incentives; and integration of economic and land use planning to assure alternative ecologically sustainable means of support to rural populations (6). Long-term support for baseline ecological research to develop systems that would permit sustainable, efficient use of tropical forests is an important element of this. Expanded anthropological and social research, especially including more attention to the role of women in forest use, also is needed to increase the likelihood that forestry projects will be accepted by the local populations and thus become self-sustaining.

References

References

1. Andrew W. Mellon Foundation, *Report of the Andrew W. Mellon Foundation 1980,* 1981.
2. Ayensu, E., "Plants for Medicinal Uses With Special Reference to Arid Zones," in *Arid Land Plant Resources,* H. Goodin and D. Northington (eds.), proceedings of the International Aridlands Conference on Plant Resources, Texas Tech University, 1979, pp. 117-178.
3. Bethel, J. S., et al., "The Role of U.S. Multinational Corporations in Commercial Forestry Operations in the Tropics," a report submitted to the Department of State, University of Washington, 1982, 306 pp.
4. Brown, R. D., and Petrello, G. T., *Introduction to Business,* 2d ed., Glencoe Publishing Co., Inc., 1979.
5. Callaham, R. Z., and Buckman, E. E., *Some Perspectives of Forestry in the Philippines, Indonesia, Malaysia, and Thailand,* U.S. Department of Agriculture Forest Service report, December 1981.
6. Christophersen, K., et al., "Response of International Donors to Forestry Problems in Developing Countries," *Journal of Forestry,* April 1982.
7. Collins, N., Program Officer in charge, Rural Poverty and Resources, Ford Foundation, personal communication, 1982.
8. Food and Agriculture Organization/U.N. Environmental Programme, *Tropical Forest Resources,* Jean-Paul Lanly, Forestry Department, Food and Agriculture Organization, Forestry Paper #30, 1982.
9. Farnsworth, N., and Loub, W., "Information Gathering and Data Bases Pertinent to Furthering the Economic Potential of Plants," OTA commissioned paper, 1982.
10. Ford Foundation, *Annual Report 1981,* 1982.
11. Fishwick, R., forester for World Bank, personal communication, 1982.
12. Hansel, R., "Medicinal Plants and Empirical Drug Research," in *Plants in the Development of Modern Medicine,* T. Swaine (ed.) (Cambridge, Mass: Harvard University Press, 1972), pp. 160-174.
13. Hormats, R., "U.S. Foreign Aid and the Private Sector: Is Partnership Possible?" hearing before the Subcommittee on Trade, Productivity, and Economic Growth of the Joint Economic Committee, U.S. Congress, 1981.
14. Laundrie, J. F., and Baker, A. J., *Report of Travel to Australia, Papua New Guinea, the Philippines, and Japan,* U.S. Department of Agriculture Forest Service, April 1979.
15. Macrae, N., "Entrepreneurial Now: Big Goes Bust," *Economist* 283:67-72, 1982.
16. Myers, N., *The Sinking Ark: A New Look at the Problem of Disappearing Species* (Elmsford, N.Y.: Pergamon Press, 1979).
17. OTA, discussion of "Technologies To Sustain Tropical Forest Resources" advisory panel, 1982.
18. Raven, P., "Basic Research: Increasing Quality of Information Needed for Development and Implementation of Technologies To Sustain Tropical Forest Resources," OTA commissioned paper, 1982.
19. Rich, B., Natural Resources Defense Council, personal communication, 1983.
20. Rich, B., "Institutions That Deal With Technologies To Sustain Tropical Forest Resources," OTA commissioned paper, 1982.
21. Rich, B., "Private Foundations That Support Projects Relating to Technologies To Sustain Tropical Forest Resources," OTA commissioned paper, 1982.
22. Riddell, J., "Causes of Deforestation and Forest Resources Degradation in Tropical Africa," OTA commissioned paper, 1982.
23. The Rockefeller Foundation, *The President's Review and Annual Report 1981,* 1982.
24. Teltsch, K., "Philanthropic Coalition to Expand Aid Abroad," *New York Times,* Jan. 31, 1982.
25. U.S. Department of Agriculture-Forest Service, *Forestry Activities and Deforestation Problems in Developing Countries,* report to the Office of Science and Technology, Development Support Bureau, and Agency for International Development, 1980.
26. Weber, F., "Combating Desertification With Trees," OTA commissioned paper, 1982.
27. World Bank/Food and Agriculture Organization of the United Nations, *Forestry Needs in Developing Countries: Time for a Reappraisal?* paper for 17th IUFRO Congress, Kyoto, Japan, Sept. 6-17, 1981.
28. Zerbe, J., et al., *Forestry Activities and Deforestation Problems in Developing Countries,* report to the Office of Science and Technology, Development Support Bureau, and Agency for International Development, 1980.

Office of Technology Assessment

The Office of Technology Assessment (OTA) was created in 1972 as an analytical arm of Congress. OTA's basic function is to help legislative policymakers anticipate and plan for the consequences of technological changes and to examine the many ways, expected and unexpected, in which technology affects people's lives. The assessment of technology calls for exploration of the physical, biological, economic, social, and political impacts that can result from applications of scientific knowledge. OTA provides Congress with independent and timely information about the potential effects—both beneficial and harmful—of technological applications.

Requests for studies are made by chairmen of standing committees of the House of Representatives or Senate; by the Technology Assessment Board, the governing body of OTA; or by the Director of OTA in consultation with the Board.

The Technology Assessment Board is composed of six members of the House, six members of the Senate, and the OTA Director, who is a nonvoting member.

OTA has studies underway in nine program areas: energy and materials; industry, technology, and employment; international security and commerce; biological applications; food and renewable resources; health; communication and information technologies; oceans and environment; and science, transportation, and innovation.

BEST AVAILABLE COPY